NAVY
PROPOSAL SUBMISSION
INTRODUCTION

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of Naval Research (ONR). The Navy SBIR Program Manager is Mr. Vincent D. Schaper, (703) 696-8528. The Deputy SBIR Program Manager is Mr. John Williams, (703) 696-0342. If you have any questions of a specific nature, you may contact one of the above persons. For general inquiries or problems with the electronic submission, contact the DoD Help Desk at 1-866-216-4095. For technical questions about the topic, contact the Topic Authors listed on the website on or before 1 July 2001.

The Navy's SBIR program is a mission-oriented program that integrates the needs and requirements of the Navy's Fleet through R&D topics that have dual-use potential. Information on the Navy SBIR Program can be found on the Navy SBIR website at **http://www.onr.navy.mil/sbir**. Additional information pertaining to the Department of the Navy's mission can be obtained by viewing the website at **http://www.navy.mil**.

PHASE I PROPOSAL SUBMISSION:

When you prepare your proposal, keep in mind that Phase I should address the feasibility of a solution to the topic. The Navy only accepts Phase I proposals with a base effort not exceeding $70,000 and with the option not exceeding $30,000. The technical period of performance for the Phase I should be 6 months and for the Phase I option should be 3 months. The Phase I option should address the transition into the Phase II effort and should be the initiation of the next phase of the SBIR project (i.e. initial part of Phase II). Phase I proposals, including the option, have a 25-page limit (see section 3.3). The Navy will evaluate and select Phase I proposals using scientific review criteria based upon technical merit and other criteria as discussed in this solicitation document. For technical questions about the topic, contact the Topic Authors listed on the website on or before **1 July 2001**. Due to limited funding, the Navy reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded. The Navy typically provides a firm fixed price contract or awards a small purchase agreement as a Phase I award.

It is mandatory that a DoD Proposal Cover Sheet and the Company Commercialization Report are submitted electronically through the DoD SBIR website at **http://www.dodsbir.net/submission**. If you have any questions or problems with the electronic submission, contact the DoD SBIR Helpdesk at 1-866-216-4095.

NEW! OPTIONAL ELECTRONIC SUBMISSION OF TECHNICAL PROPOSALS

For this solicitation, companies will have **two** options for submission of proposals to the Navy:

Option 1 -All Electronic Proposal Submission:
Complete electronic submission which will include the submission of the Cover Sheets, Cost Proposal, Company Commercialization Report, and the **entire** technical proposal including all forms via the DoD Submission site. The DoD proposal submission site **http://www.dodsbir.net/submission** will lead you through the process for submitting your technical proposal and all of the sections electronically. If you choose to submit your technical proposal electronically, it must be submitted online on or before the **3:00 pm EST, 15 August 2001 deadline,** but a hardcopy will not be required at this time. *Acceptable Formats for Online Submission:* All technical proposal files will be converted to Portable Document Format (PDF) for evaluation purposes; therefore, submissions may be received in PDF format but other acceptable formats (PC/Windows) are MS Word, WordPerfect, Text, Rich Text Format (RTF), and Adobe Acrobat. The Technical Proposal should include all graphics and attachments and should conform to the limitations on margins and number of pages specified in the front section of this DoD Solicitation. Most proposals will be printed out on black and white printers so make sure all graphics are distinguishable in black and white. It is strongly encouraged that you perform a virus check on each submission to avoid complications or delays in downloading your Technical Proposal.

Option 2 -Paper Submission of Proposal and Electronic Submission of Cover Sheets and Company Commercialization Report:
Hardcopy submission of Technical Proposal **and** electronic submission of Cover Sheets and Company Commercialization Report through the DoD proposal submission site, http://www.dodsbir.net/submission. You must print out the forms directly from this web site, sign the forms, and submit them with your hardcopy proposal. The format of your hardcopy proposal should be: Proposal Cover Sheet Pages (signed), Technical Proposal and Option (25-page limit), Cost Proposal (signed), and Company Commercialization Report (signed). **For Option 2 you must mail one original and four copies of your Phase I proposal to the address below. Proposals must be received by 15 August 2001.**

U.S Mail packages send to:
Office of Naval Research
ONR 364 SBIR

Ballston Tower #2, Room 106
800 North Quincy Street
Arlington, VA 22217-5660

<u>Mail Services or Courier packages send to:</u>
Office of Naval Research
ONR 364 SBIR
Ballston Tower#2, Room 106
801 North Randolph Street
Arlington, VA 22203

PHASE I ELECTRONIC FINAL REPORT:

All Phase I award winners must electronically submit a Phase I summary report through the Navy SBIR website at the end of their Phase I. The Phase I Summary Report is a non-proprietary summary of Phase I results and should include potential applications and benefits and not exceed 700 words. It should require minimal work from the contractor because most of this information is required in the final report. The summary of the final report will be submitted through the Navy SBIR/STTR Website at: **http://www.onr.navy.mil/sbir**, click on "Submission", then click on "Submit a Phase I or II Summary Report".

ADDITIONAL NOTES:

1. The Small Business Administration (SBA) has made a determination that will permit the Naval Academy, the Navy Post Graduate School and the other military academies to participate as subcontractors in the SBIR/STTR program, since they are institutions of higher learning.

2. The Navy will allow firms to include with their proposals, success stories that have been submitted through the Navy SBIR website at **http://www.onr.navy.mil/sbir**. A Navy success story is any follow-on funds that the firm has received from a past Phase II Navy SBIR or STTR award. The success story should then be printed and included as appendices to the proposal. These pages <u>will not</u> be counted towards the 25-page limit. The success story information will be used as part of the evaluation of the third criteria, Commercial Potential (listed in Section 4.2 of this solicitation) which includes the Company's Commercialization Report (formerly Appendix E) and the strategy described to commercialize the technology discussed in the proposal. The Navy is very interested in companies that transition SBIR efforts directly into Navy and DoD programs and/or weapon systems. If a firm has never received a Navy SBIR Phase II it will not count against them. Phase III efforts should also be reported to the Navy SBIR program office noted above.

NAVY FAST TRACK DATES AND REQUIREMENTS:

The Fast Track application must be received by the Navy 150 days from the Phase I award start date. Your Phase II Proposal must be submitted within 180 days of the Phase I award start date. Any Fast Track applications or proposals not meeting these dates may be declined. All Fast Track applications and required information must be sent to the Navy SBIR Program Manager at the address listed above, to the designated Contracting Officers Technical Monitor (the Technical Point of Contact (TPOC)) for the contract, and the appropriate Navy Activity SBIR Program Manager listed in Table 1 of this Introduction. The information required by the Navy is the same as the information required under the DoD Fast Track described in the front part of this solicitation.

PHASE II PROPOSAL SUBMISSION:

Phase II is the demonstration of the technology that was found feasible in Phase I. Only those Phase I awardees which have been **<u>invited</u>** to submit a Phase II proposal by that Activity's proper point of contact, listed in Table 1, during or at the end of a successful Phase I effort will be eligible to participate for a Phase II award. If you have been invited to submit a Phase II proposal to the Navy, obtain a copy of the Phase II instructions from the Navy SBIR website or request the instructions from the Navy Activity POC listed in Table 1. The Navy will also offer a "fast track" into Phase II to those companies that successfully obtain third party cash partnership funds ("Fast Track" is described in Section 4.5 of this solicitation). The Navy typically provides a cost plus fixed fee contract or an Other Transition Agreement (OTA) as a Phase II award. The type of award is at the discretion of the contracting officer.

Upon receiving an invitation, submission of a Phase II proposal should consist of three elements: 1) a $600,000 base effort, which is the demonstration phase of the SBIR project; 2) a separate 2 to 5 page Transition/Marketing plan (formerly called a "commercialization plan") describing how, to whom and at what stage you will market/transition your technology to the government, government prime contractor, and/or private sector; and 3) at least one Phase II Option ($150,000) which would be a fully costed and well defined section describing a test and evaluation plan or further R&D if the Transition/Marketing plan is evaluated as being successful. Phase II efforts are typically two (2) years and Phase II options are typically an additional six (6) months. Some Navy Activities have different schedules and award amounts; you are required to get specific guidance from them before submitting your Phase II proposal. Phase II proposals together with the Phase II Option are limited to 40 pages (unless otherwise directed by the TPOC or contract officer). The Transition/Marketing plan must be a separate document that is submitted through the Navy SBIR website under "Submission" and included with the proposal hard copy. All Phase II proposals must have a Proposal Cover Sheet and Company Commercialization Report submitted through the DoD SBIR website at **http://www.dodsbir.net/submission** and Transition/Marketing plan submitted through the Navy SBIR website at **http://www.onr.navy.mil/sbir**.

All Phase II award winners must attend a two day Commercialization Assistance/Business Plan Development Course from the Navy. This is typically taken at the beginning of the 2nd year of the Phase II. If you receive a Phase II award, you will be contacted with more information regarding this program.

As with the Phase I award, Phase II award winners must electronically submit a Phase II summary report through the Navy SBIR website at the end of their Phase II. The Phase II Summary Report is a non-proprietary summary of Phase II results and should include potential applications and benefits and not exceed 700 words. It should require minimal work from the contractor because most of this information is required in the final report. The summary of the final report will be submitted through the Navy SBIR/STTR Website at: **http://www.onr.navy.mil/sbir**, click on "Submission", then click on "Submit a Phase I or II Summary Report".

The Navy has adopted a New Phase II Enhancement Plan to encourage transition of Navy SBIR funded technology to the Fleet. Since the Law (PL102-564) permits Phase III awards during Phase II work, the Navy will provide a 1 to 4 match of Phase II to Phase III funds that the company obtains from an acquisition program. Up to $250,000 in additional SBIR funds can be provided as long as the Phase III is awarded and funded during the Phase II. If you have questions, please contact the Navy Activity POC.

Effective in Fiscal Year 2000, a Navy activity will not issue a Navy SBIR Phase II award to a company when the elapsed time between the completion of the Phase I award and the actual Phase II award date is eight (8) months or greater; unless the process and the award has been formally reviewed and approved by the Navy SBIR Program Office. Also, any SBIR Phase I contract that has been extended by a no cost extension beyond one (1) year will be ineligible for a Navy SBIR Phase II award using SBIR funds.

TABLE 1. NAVY ACTIVITY SBIR PROGRAM MANAGERS POINTS OF CONTACT (POC) FOR TOPICS
Topic Numbers N01-108 to N01-112
Mr. Rod Marzano
MARCOR
&03-784-1395

Topic Numbers N01-113 to N01-130
Mr. Bill Degentesh
NAVSEA
202-781-3740

Topic Numbers N01-131 to N01-149
Mr. Douglas Harry
ONR
703-696-4286

Topic Numbers N01-150 to N01-152
Ms. Susan Schneck
NAVSUP
717-605-1305

Topic Numbers N01-152 to N01-183
Ms. Carol Van Wyk
NAVAIR
301-342-0215

Do not contact the Program Managers for technical questions. For technical questions, please contact the topic authors during the pre-solicitation period from 1 May 2001 until 1 July 2001. These topic authors are listed on the Navy website under "Solicitation" or the DoD website. After 1 July, you must use the SITIS system listed in section 1.5c at the front of the solicitation or go to the DoD website for more information.

PHASE I PROPOSAL SUBMISSION CHECKLIST:

All of the following criteria <u>must be met</u> or your proposal will be REJECTED.

____1. The DoD Proposal Cover Sheet and the DoD Company Commercialization Report have been submitted electronically through the DoD submission site.

____2. The Phase I proposed cost for the base effort does not exceed $70,000. The Phase I Option proposed cost does not exceed $30,000. The costs for the base and option are clearly separate, and identified on the Proposal Cover Sheet, in the cost proposal, and in the work plan section of the proposal.

____4. Submission:
Option 1) Cover Sheets, Company Commercialization Report, and Technical Proposal have been submitted online on or before 15 August 2001.
Option 2) Cover Sheets and Company Commercialization Report (submitted online) and an original and 4 copies of the entire PH I proposal must be received on or before 15 August 2001 at the address above. The Navy will not accept late or incomplete proposals.

NAVY 01.2 SBIR TITLE INDEX

Marine Corps Systems Command (MARCORP)

N01-108 Through the Wall Sensor
N01-109 Ti:Sapphire Hybrid Laser
N01-110 Non-Intrusive, Window Mounted, Conformal Antennas
N01-111 Wireless Radio Frequency Communication Link for Small Unmanned Ground Vehicles
N01-112 Internal Periscope Displays for Embedded Training

Naval Sea Systems Command (NAVSEA)

N01-113 Shipboard SMART Foundation Adapter
N01-114 Automated Shipboard Food Service
N01-115 Hn System Integration Rapid Analysis Tool for Evaluation of System Concepts Early in Development
N01-116 Embedded Training in an Optimized Manning Environment
N01-117 Non-Lethal Ship Defense Response Systems (Anti-surface)
N01-118 Surveillance of Ship Security Perimeter While in Port
N01-119 Simulation Environment in Support of Non-Cooperative Target Recognition (NCTR) Algorithm Development
N01-120 Global Positioning System (GPS) Jamming Situational Awareness for Naval Surface Fire Support (NSFS)
N01-121 Non-GPS Projectile Navigation
N01-122 Modeling High-Temperature Erosive Gas Flow to Support Barrel Erosion Reduction Concept Modeling for Fire Support Gun Application
N01-123 Wireless Audio/Video Headsets
N01-124 Advanced Power Distribution Systems
N01-125 Scale Prevention in Seawater and Freshwater Flushed Shipboard Sanitary Waste Systems
N01-126 Advanced Treatment Technology for Shipboard Non-Oily Wastewater
N01-127 Tactical Sonar Data Fusion
N01-128 Novel Approaches for Automated Information Processing of Active Sonar Data
N01-129 Thermal Stress Management of Infrared (IR) Windows
N01-130 Integrated Underwater Sensing System for Platform Safety & Threat Alertment

Office of Naval Research (ONR)

N01-131 Multiple-Beam Electron Gun for High Power Amplifiers
N01-132 Low-cost. Lightweight, Mid-Wave InfraRed (MWIR) Sensors
N01-133 Maritime Intelligence, Surveillance, Reconnaissance (ISR) and Space Exploitation
N01-134 Component Level, Multimedia communication technology for survivability
N01-135 Boost-Phase Sub-Unit Vaccine Development for Binary Vaccines Against Infectious Diseases and Biological Warfare Agents
N01-136 Digital Cellular-Phone Transceiver-based Foliage Penetration Interferometric SAR for EO/IR Sensor Fusion ATR
N01-137 Expeditionary Logistics
N01-138 A Self-Contained Solar Radiation Measurement Package for an Aircraft
N01-139 Smart Low Altitude Platform for Atmospheric Measurements from a Research Aircraft
N01-140 Conductive Carbon Nanotubes for EMI Shielding of Naval Aviation Optical Materials
N01-141 Portable Emissivity / Reflectometer for Measurements on Curved Surfaces
N01-142 Rapid RF Switching Conducting Polymers
N01-143 Compact, Digital Man-Portable Infrared (IR) Measurement Device
N01-144 Small Diesel Engines, JP5 / JP8 Fueled
N01-145 Very Low Cost, Lightweight Detector Technologies for Small, Expendable Unmanned Air Vehicles (UAVs)
N01-146 Airframe Construction for Small, Expendable Unmanned Air Vehicles (UAVs)
N01-147 Very Low Cost Unmanned Air Vehicle (UAV) Avionics
N01-148 Very Low Cost, Lightweight IridiumTM / GlobalstarTM Communications Modules
N01-149 Expendable Active Battle Damage Assessment Sensors

Naval Supply Systems Command (NAVSUP)

N01-150 Technology for Logistics Productivity
N01-151 Laboratory Convective / Steam Heat Test Apparatus

N01-152 Environmentally Friendly Advanced Food Packaging

Naval Air Systems Command (NAVAIR)

N01-153 Low Volatile Organic Content (VOC) Solid Film Lubricant
N01-154 Probabilistic Mission/Engine Duty Cycle Analysis
N01-155 Coupled Vertical/Short Takeoff and Landing (VSTOL) Down Wash-Ground Effect and Ship Air Wake Turbulent Flow Simulation Model
N01-156 Nonlinear Combustion Stability Prediction of Solid Rocket Motors
N01-157 Transparent, Electrically Conductive Coatings for Infrared Windows
N01-158 Enhanced Propeller Visibility
N01-159 Material Encoded Textures with Computer Generated Forces (CGF)
N01-160 Aluminum Honeycomb Panel/Substructure Replacement Initiative
N01-161 Active and Passive Reduction of Noise Caused by Bone Conduction to the Head of U.S. Navy Deck Crew Personnel with Helmets
N01-162 Active Noise Reduction Earplug and Improved Speech Intelligibility for Aircrew and Deck Crew Personnel with Helmet Integrated Communication Systems
N01-163 High-Voltage Cables and Connector
N01-164 Fiber Optic Cables and Connectors
N01-165 Corrosion/Erosion Resistant Coatings for Turbine Compression Systems
N01-166 Multi-Channel Electronic Scanning Module for an Ultrahigh Frequency (UHF) Circular Array
N01-167 Fuel Reformulation to Reduce Contaminants
N01-168 Thin Layered Damping Treatments for Turbo Machinery
N01-169 Non-Mechanical Beam Steering for Infrared Countermeasure (IRCM) Applications
N01-170 New Cooling Technology to Increase Aircraft Generators Power Rating
N01-171 Visualization and Quantification System for Modeling Unsteady Aerodynamics for Aircraft Simulations
N01-172 New Mid-Infrared (IR) Laser Materials
N01-173 Non-Explosive Broadband Acoustic Source for Multi-Static Anti-Submarine Warfare (ASW)
N01-174 Wireless Leave-In-Place Aircraft Structural Nondestructive Evaluation (NDE) Sensors
N01-175 CODEC (Code/Decode) for Digital Buoys in a Harsh RF Environment
N01-176 Fiber Optic Ethernet for Aviation Intercommunications System Voice Transmission
N01-177 Hydraulic Seal Replacement
N01-178 Photonic Switching for Aircraft Fiber Optic Networks
N01-179 Low-Cost Dual-Mode (Visible/Infrared) Imager
N01-180 Low-Cost Global Positioning System (GPS) Oscillator
N01-181 Automated Strike Package Planning System
N01-182 Advanced Modeling to Characterize Failure Progression Rates from the Incipient Stage to Component Failure
N01-183 High-Temperature/Lower Cost Appliqué Material

Marine Corps Systems Command (MARCORP)

N01-108 TITLE: Through the Wall Sensor

TECHNOLOGY AREAS: Sensors, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT IV (T): Clear Facilities

OBJECTIVE: This topic seeks to develop an advanced sensor system or system of systems that will provide a capability for the clandestine determination of the location, armament, and other tactical information on personnel and equipment/materiel through a wall from a remote location.

DESCRIPTION: The Marine Corps needs a capability to sense/determine the location, armament, and other tactical information on personnel and equipment/materiel through a wall from a remote location. The system can be continuous, intermittent, or utilize an active initiator system like radar. The minimum range required is from the outside wall of the target building or the surface of the ground outside an underground location. It is desired that the system work at as long a range and through as many types of construction materials as possible including caves, tunnels, or underground bunkers. It is not essential that one technology work through all possible materials. The range desired is 100 meters from the outside wall of the target building or the surface of the ground outside an underground location. A sensor that will work from the outside surface of the building or the ground for underground structures would be the absolute minimum capability. The system needs to be clandestine, i.e. setting off explosions and reading reflected sound waves like the systems used for oil exploration would not be acceptable.

PHASE I: Determine insofar as possible the scientific, technical, and commercial merit and feasibility of a system or system of systems to provide the desired capability. Develop the technology with brassboard models of the critical components that demonstrates the applicability to infrared, electromagnetic, directed energy, acoustic or any other detectable or producible signatures. Perform a demonstration of the developed model by the end of this phase. Provide an estimate of the cost, schedule, technical performance and risk of the demonstrated capabilities.

PHASE II: Build prototypes of the model from Phase I. The prototypes shall be produced to best commercial practices. If additional commercially available technologies are required to address additional materials of construction or increased range, provide a demonstration of the total system. Develop a commercial marketing plan for the system.

PHASE III: Further develop the system for both commercial and military applications. The resultant system shall be made commercially available by the close of Phase III.

COMMERCIAL POTENTIAL: Military, fire & rescue, and law enforcement organizations have a need to determine the location of people and material inside of buildings.

REFERENCES:

1. There are no fielded capabilities in the military. Several companies have indicated that there is some capability but either the display of information requires an engineer to interpret or there are too few materials that can be seen through to make it feasible
2. Mission Need Statement for Clear Facilities Reference number, LOG 1.85, 02/20/96

KEYWORDS: Remote sensors, Sensors, Acoustic Technology, Lasers, Directed energy

N01-109 TITLE: Ti:Sapphire Hybrid Laser

TECHNOLOGY AREAS: Sensors, Electronics

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: COBRA- ACAT (IV)

OBJECTIVE: Develop a multi-wavelength Hybrid Ti:Sapphire/Nd:YAG laser system with high output pulse energy and the ability to achieve five simultaneous output wavelengths to accomplish active multispectral aerial reconnaissance.

DESCRIPTION: Recent program success under the Joint Mine Detection Technology program has produced a hybrid design laser capable of operating at four simultaneous wavelengths (Ref. 1,2). Due to certain materials properties in the Cr:LiSaf portion of the device power is limited in two of the wavelengths. A better design with higher power, a possible extra 5th wavelength, tunability across a portion of the spectrum, and a more compact design could be obtained through a design around a Ti:Sapphire/Nd:YAG laser. This newer hybrid laser would provide more output power and extra wavelength capability. Diode pumping offers the possibility of a more compact design and tuning expands operational range. Recent developments in pump lasers and Sapphire quality show promise to allow for hundred plus millijoule energy per pulse output. Current military reconnaissance programs could greatly benefit from the simultaneous active multi-wavelength imaging capability of this hardware. The range-gated capability of the multi-wavelength device will allow imaging systems to penetrate obscurants and water. The high power energy will ensure optimum capability to penetrate obscurants while providing plenty of photons for night time imaging. Selected invisible wavelengths could be used for clandestine night time imaging.

PHASE I: Investigate enabling technologies and component designs and relate the results to a hybrid laser system design capable of providing five simultaneous wavelength outputs at high energy per pulse to provide sufficient illumination for night time and through the water imaging while maintaining compactness and modularity. Consider diode pumping, tunability, and polarization capability to enhance system design. Provide details into possible prototype designs and use modeling, analysis, empirical testing or construction of risk reduction parts or sub assemblies to ensure optimum path. The results of the investigation must include a technology optimization path and system design that will provide a guide to Phase II activity.

PHASE II: Utilize the findings established in Phase I to design, develop, construct, test, and deliver a functional fieldable system prototype of the enabling technology which can be applied, with matched specifications, to support a variety of sensor systems. System functionality, capability, flexibility, and usability should be maximized for aerial reconnaissance.

PHASE III: Advancement in compact and modular illumination systems can serve both the civilian and military needs. Common application needs include navigation, law enforcement, security systems, hazardous environment monitoring, and surveillance. Additional military applications include reconnaissance, targeting, IFF, guidance, and other overt/covert operations support.

COMMERCIAL POTENTIAL: This system could provide useful information to a variety of industry areas including remote sensing, biomedical imaging, environmental and agricultural monitoring, pollution monitoring, navigation, and law enforcement,

REFERENCES:

1. Holloway, Xybion Electronic Systems Corporation, “Multispectral Hybrid Laser Phase II Test Plan for Laboratory and Field Measurements”, Apr 99
2. Lin, Andriasyan, Swatrtz, Witherspoon, Holloway, “Multiwavelength output from a Nd:YAG/Cr:LiSAF hybrid laser”, Applied Optics, Vol 38, No. 9, Mar 99.
3. Witherspoon, Holloway, "Feasibility Testing of a range-gated laser illuminated underwater imaging system," Proceeding of the International Society for Optical Engineering, Vol 1302, Ocean Optics X, April 1990, pp 414-420.
4. Witherspoon, Holloway, et. al., "Measured Degradation in Image Quality When Imaging Through A Wavy Air-Water Interface, Proceedings of the Society of Photo-Optical Instrumentation Engineers, Ocean Optics IX, April 1988.
5. Witherspoon, Holloway, et. al., "Experimentally Measured MTF's Associated with Imaging Through Turbid Water," Proceedings of the Society of Photo-Optical Instrumentation Engineers, Ocean Optics IX, April 1988.
6. Holloway, Lorenzo, Pham, "Gated Laser Video Sensor (GLVS) Large Area Smoke Experiment (LASEX) Report," NCSC Report, Oct 94
7. Holloway, "Gated Laser Video Sensor Smoke Week Test Plan," NCSC Report, April 94
8. Witherspoon, Holloway, et. al., "Experimental Results of Single Pulse Imaging Through Turbid Water of up to 2 Meter Depth Using a Blue-Green Short Pulse Width Laser and a CID Gated Array Camera System." NCSC Technical Report.
9. Blume, "Enhancement of the Gated Laser Video Sensor Image Synthesis Tool - Final Report,"
10. Blume, "Gated Laser Video Sensor Image Synthesis Tool Simplified Model - Final Report," Oct 94
11. Blume, "Gated Laser Video Sensor Image Synthesis Tool Simplified Model - Users Manual," Oct 94

KEYWORDS: Laser Diode Array, Diode Array, LADAR, Range Gating, Gated Imaging, Laser Radar

N01-110 TITLE: Non-Intrusive, Window Mounted, Conformal Antennas

TECHNOLOGY AREAS: Sensors

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT IV: MARCORSYSCOM PM INTEL

OBJECTIVE: This project will result in allowing signals collection teams to attach a portable wideband membrane antenna to the inside of windows of various platforms. These antennas may be utilized as a single unit or as arrays. This will allow use of any available platform for signal collection without concern for the safety and space requirements encountered with external antennas.

DESCRIPTION: USMC Radio Battalions are required to provide signal collection operations with organic resources. Collection platforms are frequently not available with antennas of characteristics required for frequencies of interest. Thus the Marine is required to utilize any non-dedicated platform (man/team, air, ground, water, etc) and make do with antenna suites that happen to reside on the platform. This program is focused on developing conformal membrane antennas that can be mounted inside the windows of these platforms. The technology utilized for the development of these non-intrusive conformal antennas is fractal antenna design. Fractal antenna design techniques have been studied for antenna application over the past decade and are particularly suited for this application.

PHASE I: Develop a set of performance models and equations to predict and optimize the expected performance of fractal antenna designs of various sizes. Particular emphasis will be placed on determining the optimal fractal membrane structure balancing portability, gain, pattern, and conformal characteristics.

PHASE II: Develop and test a set of engineering development prototype antennas (four 4). This will include measurement of antenna pattern and gain in an antenna range environment. Field testing on candidate platforms will follow the range testing.

PHASE III: Production of antennas for USMC Radio Battalions use.

COMMERCIAL POTENTIAL: The commercial potential of this antenna technology includes furthering the development of the practice of Fractal Antenna Design and a new class of antennas for amateur radio use which may allow ‘hams’ to enjoy their hobby in city environments where construction of large antenna structures is not allowable.

REFERENCES:

1. Fractal Antenna Engineering: The Theory and Design of Fractal Antenna Arrays. Werner, Douglas H, et al, IEEE antennas & propagation magazine. OCT 01 1999 v 41 n 5 37.
2. On the Behavior of the Sierpinski Multiband Fractal Antenna. Puente-Baliarda, C. et al, IEEE transactions on antennas and propagation. APR 01 1998 v 46 n 4   517.

KEYWORDS: Antennas, Conformal, Fractals, Wideband, Apertures, and Communications

N01-111 TITLE: Wireless Radio Frequency Communication Link for Small Unmanned Ground Vehicles

TECHNOLOGY AREAS: Sensors, Electronics

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT III, GLADIATOR Program

OBJECTIVE: Design and build a Wireless Radio Frequency (RF) Communication Link for small Unmanned Ground Vehicles (UGV) to allow them to effectively operate in enclosed spaces such as sewers, tunnels, and buildings without utilizing a physical tether for communications between the operator and the UGV.

DESCRIPTION: Small UGVs have been used in past experiments to conduct tunnel, sewer, and building reconnaissance missions. The purpose of these missions is to use UGVs in place of Marines and Soldiers to locate booby traps such as trip wires, mines, and snipers, thereby removing them from harm’s way. These vehicles carry a variety of sensors on-board to allow the UGV to provide situational awareness data to the operator. This information is then forwarded to the battlefield decision makers to allow them to plan their missions to mitigate loss of Marines and Soldiers lives.

The small UGVs currently being utilized to demonstrate these capabilities use commercial off-the-shelf, radio frequency (RF) communications links to transmit information between the operator and UGV. These communication links do not work well in enclosed spaces due to the nature of RF energy propagation. Typically, the UGV will get some distance into the sewer, tunnel, or building and the communications link will drop out, thus disabling the UGV. At this point, the data feedback to the operator is also disabled. This is not an acceptable result or conclusion to the mission.

There are emerging requirements for small UGVs to support Military Operations in Urban Terrain (MOUT), Operations Other Than War (OOTW), and Ship to Objective Maneuver (STOM) operations. This effort will use emerging technologies to design a Wireless RF Communication Link that is optimized for use on small UGVs in these environments. It will incorporate innovative types of modulation and data compression schemes, antenna design techniques, and power management technologies to enhance the propagation characteristics of the RF energy, thus allowing the UGVs to complete their missions.

Successful submissions will propose solutions for short range (100-500m) wireless communication between UGVs and the operator, operating in enclosed spaces such as corridors, ventilation shafts, utility tunnels, sewer pipes, and evacuated water mains. Proposed solutions will also address non-line-of-sight issues arising from corners and bends, and reflection and multipath interference issues arising from RF waveguide effects of confined spaces. Solutions should also address the power, weight, and volume constraints inherent with small UGVs.

PHASE I: Design a Wireless RF Communication Link system for use on small UGVs in enclosed environments. This system will have the capability to transmit near real-time, digitized video and status data from the UGV to the operator and control data from the operator to the UGV inside enclosed environments with a high degree of confidence. It will also have data relay capabilities to allow the UGV information to be integrated into the battlefield Command, Control, and Communications (C3) networks.

PHASE II: Develop and test a prototype unit. This unit will be integrated into a small UGV and tested in government test facilities. The performance characteristics will be compared against currently used, commercial off-the-shelf RF communications links.

PHASE III: Design changes will be initiated to solve design problems, integrate producibility and manufacturability into the design, and develop a technical data package for this system. The Wireless RF Communication Link will be integrated into the U.S. Marine Corps GLADIATOR and U.S. Army's Man-Portable Robot System (MPRS) UGV programs.

COMMERCIAL POTENTIAL: The potential for commercializing this product is tremendous. This Wireless RF Communications Link could be utilized in any enclosed work environment requiring wireless local area networks (LAN) for data communications. Current technologies used for LANs are susceptible to interference, jamming, and increased electromagnetic noise levels. The technologies developed under this effort will be inherently less susceptible to these types of interference because mitigation of this type of interference is part of the design of the system.

KEYWORDS: Radio; unmanned; data; communications; tunnel; wireless.

N01-112 TITLE: Internal Periscope Displays for Embedded Training

TECHNOLOGY AREAS: Information Systems, Ground/Sea Vehicles

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: Advanced Amphibious Assault Vehicle (AAAV), ACAT ID

OBJECTIVE: Develop and demonstrate a Visual Display monitor that can be built into the periscopes on the AAAV. The display will remain permanently inside the periscopes. It must have two modes; one in which it is switched OFF i.e. positioned out of the way so that the vehicle operators can see through the periscope to the outside of the vehicle; and a second position where the display is switched ON, i.e. positioned in the periscope path to become an opaque display for presenting the simulated Out-the-Window (OTW) view provided by the on-board Embedded Training Simulator server.

DESCRIPTION: During the past decade the U.S. Army and U.S. Marine Corps, in parallel with many foreign militaries, have demonstrated their commitment to deployable "embedded training" using appended, or "strap-on", simulation and control systems to make operational armored vehicles serve a second purpose as a crew trainer. Armored communities place the highest priority on deployable embedded training to sustain highly erodable skills. Marine Corps units embarked on Naval Ships are in special need of high quality training devices sufficient for maintaining the crucial precision gunnery skills of target detection, identification, and engagement. Computer servers for embedded training have been miniaturized and ruggedized to a state that they can be fully integrated into the armored vehicle. However, visual displays must still be carried in separate packaging and strapped on manually whenever simulation training is desired. External displays are at risk of being left behind as embarkation space is given to higher priority war supplies such as ammunition, food, and water. Displays that have labor intensive installation and exposed cabling are at risk of severe damage during installation and use by Marines. Reliable, robust displays are crucial to the success of embedded training. The optimal solution would be displays that are permanently built into the vehicle with no exposed cabling. The most natural display location for training would be at the periscopes so that operators would look to the same location whether they are looking out to the real world or using the embedded training simulator system. Flat panel displays that could be made small enough to "strap-on" to the periscopes would partially fill the need but would still have the high likelihood of becoming damaged to the point of being unusable. Any display solution that requires storage, installation, and exposed cabling cannot be expected to survive in the rugged environment experienced by AAAV. Fully integrated displays are needed to provide superior training devices for the life of the vehicle.

PHASE I: Perform a feasibility study and develop a preliminary design to describe the following: (a) Mechanism for a display that can be switched or moved to provide an "ON" mode where it functions as a display, and an "OFF" mode where it is out of the visual path. (b) Potential to be mounted internally in periscopes with sufficient image quality to serve as a training device. (c) Method for receiving signals from a computer server to provide graphic imagery. (d) Electrical power requirements. (e) Provide an estimate of the cost, schedule, technical performance, risk, and producibility of the desired capability.

PHASE II: Develop a detailed design and produce prototypes to demonstrate the capabilities described in Phase I.   Multiple prototypes of varying form can be used to demonstrate different aspects of the design.   One prototype must demonstrate that the design can provide sufficient image quality to serve as a training device display. One prototype must demonstrate, inside a mock-up of the AAAV periscope, the mechanism to be used which allows the display to be visible on command and be move out of the visible path on command. Each prototype must demonstrate the capability respond to contractor provided computer imagery software. Update and refine the estimate of the cost, schedule, technical performance, risk, and producibility of the desired capability. Develop a commercial marketing plan for the system.

PHASE III: Integrate display design with the AAAV Embedded Training software. Fabricate ruggedized periscope displays of appropriate size to fit in the AAAV driver's periscopes and the AAAV Vehicle Commander's periscope. Produce sufficient periscope displays to outfit one AAA Vehicle. Integrate the periscope displays into AAAV periscope housings.   Determine reliability characteristics of the internal periscope displays. Demonstrate producibility and develop an implementation plan for new production. Further develop the system for both commercial and military applications. The resultant system shall be made commercially available by the close of Phase III.

COMMERCIAL POTENTIAL: The commercial video gaming industry can benefit from the miniaturization of displays for creating high quality visual displays with small volume space claims. Commercial applications which use a display surface that would benefit from being transparent at times such as the commercial automotive industry which has featured instrument panel readouts shown on the windshield.

KEYWORDS: Displays, miniaturization, training, internal, simulation, embedded.

Naval Sea Systems Command (NAVSEA)

N01-113   TITLE: Shipboard SMART Foundation Adapter

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT 1: DD21

OBJECTIVE: Develop and demonstrate a standard, lightweight, low-cost adapter to accommodate shipboard COTS equipment and provide a flexible, reconfigurable interface to the shipboard standard foundation interface SMART Track mounting system and shipboard equipment.

DESCRIPTION: Shipboard electronics and other spaces require frequent upgrades and/or reconfigurations due to technology and other changes; such changes are only projected to multiply with increased use of COTS for military systems. Often these upgrades require extensive ship alterations associated with modifying ship support services. To decrease costs and increase adaptability, open interfaces for equipment foundations are becoming a reality with the use of SMART (Shipboard Modular Arrangement Reconfiguration Technology) Track on Navy ships. SMART Track is a modular commercial foundation system based on ISO Standard 7166 and is currently installed on several Navy ships. SMART track installations provide a significant cost avoidance by simplifying the structural work involved in reconfigurations or upgrades. However, current installations of equipment to SMART track require the use of individually constructed intermediate foundations to connect equipment to the SMART interface grid. This can result in additional costs and in the equipment and consoles being raised several inches creating potentially unacceptable ergonomic arrangements. A significant cost avoidance would result from the development, qualification, and implementation of a standard, flexible adapter family to serve as the interface between various equipment types and mounting orientations and the standard SMART Track foundation. Such an adapter would be subject to demands of the Navy unique environment and must meet rigorous shock and vibration requirements. This adapter will be designed to eliminate the requirement to design and conduct shock analysis for each individual equipment foundation and allow flexible console/rack orientation and reconfiguration. This adapter will provide a low profile, direct link to equipment and consoles located in shipboard spaces.

PHASE I: Develop a standard, flexible, reconfigurable, low-cost, light-weight adapter family design for a range of shipboard electronic console applications. Conduct a study of the lifecycle costs and feasibility for use with the projected range of current and future shipboard electronics equipment. Develop a prototype and evaluate feasibility in the Navy unique environment with respect to shock and vibration requirements by conducting computational shock analysis.

PHASE II: Analyze, fabricate, and test the designs developed in Phase I. Conduct physical testing to validate that the designs can meet the requirements of NAVSEA 0908-LP-000-3010, Rev. 1 (or most recent Revision) “Shock Design Criteria for Surface Ships.” Evaluate and project the lifecycle costs associated with the adapter. Validate the applicable ranges of individual adapters within the adapter family (weight, center of gravity, etc.).

PHASE III: Demonstrate and document the adapter's projected lifecycle costs, producibility, and adaptability for multiple equipment configurations as part of the installation and testing within a ship electronics space. Validate the adapter's shock/vibration qualification. Develop a plan to incorporate the adapter on CG 47 and LPD 17 Class ships as shipboard electronics spaces undergo construction or conversion.

COMMERCIAL POTENTIAL: Commercial ships that utilize electronic equipment could benefit from the incorporation of such adapters coupled with the ISO 7166-based SMART Track concept to maintain currency with the ever-advancing electronic/computing technologies by providing a low cost, rapid upgrade potential.

REFERENCES:

1. NAVSEA 0908-LP-000-3010, Rev. 1 (or most recent Revision) "Shock Design Criteria for Surface Ships".
2. NAVSEA Technical Manual S6468-AA-INM-010, "Technical Manual for Shipboard Modular Arrangement Configuration Technology (SMART) System SMART Design Guidance".
3. NAVSEA Technical Note No. 070-PMS335-TN-0018, "C4I Modular Implementation Working Group C4I Modular Foundation Study".
4. ISO Standard 7166.

KEYWORDS: Adapter; SMART Track; electronic equipment; foundation; mounting; interface.

N01-114 TITLE: Automated Shipboard Food Service

TECHNOLOGY AREAS: Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: DD-21

OBJECTIVE: Develop and demonstrate automated shipboard food service processes and technologies that will significantly reduce shipboard food item preparation, serving, and scullery manning requirements through automated identification, retrieval, transportation, processing, and preparation of menu items while enhancing the food quality and availability.

DESCRIPTION: The loading, stowage, preparation, and serving of meals to US Navy shipboard personnel is presently a manpower-intensive operation as is the cleanup of cooking, serving, and eating utensils and disposal of foodservice waste (scullery functions). These shipboard processes are almost entirely manual with minimal modern equipment and little automation; others do not positively effect the morale of shipboard personnel. Requested is an integrated system(s) addressing food item preparation as well as clean-up to eliminate the workload currently associated with these operations. The Food Item Preparation System (FIPS) would automate the identification, retrieval, and transportation of food items from the shipboard dry, chill, and freeze storerooms to the preparation area(s) (galley). The FIPS would also initiate, monitor, and control food item preparation and serving processes within the galley. Inventory and menu management features would support automatic recordkeeping and ordering. The Scullery Management System (SMS) is the counterpart to FIPS and will perform scullery functions such as messgear scrapping, soaking, washing/drying, and stowage, with no attendant manpower requirements. The FIPS and SMS will be developed with a modular, open systems architecture approach to permit lifecycle upgradability, flexibility for inclusion of various commercial technologies/systems, and application across various ship platforms and Navy/Industry support concepts. The FIPS and SMS are envisioned to include computer-controlled sensors and operating mechanisms able to operate in refrigerated spaces and withstand shipboard motions/ environment. Previously, technology insertion aboard Navy ships has occurred at the piece-part level and current shipboard foodservice arrangements do not facilitate upgrade or modernization except in the most rudimentary manner. Existing Navy ships typically are configured with foodservice storerooms separated from the food production areas, contributing to manpower-intensive stores handling. The development of a re-engineered foodservice system and the implementation of innovative automation technologies to minimize the manpower requirements for shipboard foodservice are required. New methods and techniques for the stowage, retrieval, preparation, and management of menu items are required. These new methods must employ automation and mechanical aids designed for operation aboard Navy ships and must reduce overall ship system requirements such as chill/frozen storage.

PHASE I: Develop an automated FIPS and SMS concept for Navy surface combatants to eliminate Scullery manning requirements and reduce the number of food item preparation and serving personnel. Identify the resultant manning reduction, lifecycle costs and shipboard impacts and performance in the Navy unique environment. Develop prototypes and demonstrate key equipment and processes. Identify required equipment, menu and menu items, concept of operations, architectures, and interfaces including HSI, ship-machine and with existing and planned logistical support communities.

PHASE II: Prototype the automated foodservice concept as determined in Phase I. Demonstrate (land-based) the operation of processes and individual items including defining maintenance procedures and projecting lifecycle costs for all Navy shipboard operational scenarios. Define interface boundaries and conditions for new system processes and equipment to address legacy

Navy systems such as shore-side/underway logistics systems, inventory management/accounting tools, and ship general arrangements. Evaluate performance in the Navy unique environment including shock and vibration requirements.

PHASE III: Demonstrate the automated foodservice system configuration aboard a US Navy ship operated by Navy personnel. Document manpower reduction, lifecycle cost projections, maintenance requirements, impacts and interfaces with other ship systems and the existing and planned logistical support communities, and performance in the Navy unique environment. Develop a plan to incorporate automated foodservice system concept on new construction US Navy platforms.

COMMERCIAL POTENTIAL: Cruise ships, cargo ships, tankers, and workboats in the commercial sector could benefit from the incorporation of automated food service technologies and approaches, as could MSC and USCG ships. US Navy shore-side and other governmental, institutional, and commercial installations could benefit from automation and other technologies used to reduce manpower and streamline system operation; the ability to effectively employ an automated foodservice system within a confined [shipboard] area will appeal to the commercial sector as a cost-effective space optimization measure.

REFERENCES:

1. "NAVSUP Advanced Food Study aboard USS McFaul", Naval Supply Systems Command, Mechanicsburg, PA, September, 1999.
2. "Modular Reefer Box Technology Demonstrator", Naval Sea Systems Command, Affordability Through Commonality Program (PMS 512), Arlington, VA, December, 1997.
3. “Co-Located Galley Life Cycle Cost Analysis for the Affordability Through Commonality Program,” August 1997,prepared by Naval Sea Systems Command, PMS 512 under Contract # N00024-92-C-4215: TI 6A016.
4. "Commercial Applications in Aircraft Carriers", Naval Sea Systems Command, PMS 312, Arlington, VA, March, 1999, prepared by MSCL Incorporated under Contract # N00024-95-C-4180: TIs 7J201, 8J008, 8J020, and 8J108.

KEYWORDS: Automation; food processing; food preparation; food stowage; food procurement; sustainment.

N01-115 TITLE: Human System Integration Rapid Analysis Tool for Evaluation of System Concepts Early in Development

TECHNOLOGY AREAS: Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: DD-21

OBJECTIVE: Develop and demonstrate a computer-based human systems integration (HSI) tool that supports the rapid assessment of human performance, health and safety issues, and average expected workload for a ship manpower optimization concept (or concepts). To accomplish this, the tool should use characteristics of the tasks, task timelines, situation awareness, and tactical perspective. The tool should produce manpower summaries for competing automation concepts by NEC and rating, or other suitable descriptors of the necessary operator/maintainer knowledge, skills, abilities (KSAs) and experience. The tool should help assess the extent a design concept enhances or impedes the situation awareness and tactical perspective. These outputs should be directly applicable in trade studies assessing the expected manpower cost and human performance aspects of competing system concepts. The tool should also provide the basis for quick assessments of the aspects of a design concept that will impact human performance, safety, or health in an optimized manning environment.

DESCRIPTION: Manpower reductions or manpower optimizations are features of many current Navy acquisition projects. In some instances, it may be possible to specifically state which watchstanders or maintainers dedicated to a given shipboard system can be eliminated, provided the corresponding hardware operations or maintenance activities can be fully automated, deferred, or otherwise eliminated. More typically, however, watchstanders or maintainers work across a variety of related systems. In such cases, system concepts for complete automation, partial automation with supervisory control, remote operation, reliance on decision support systems, etc. produce distributed workloads that must be allocated to individuals having the necessary KSAs, and then rolled up across systems for a given category of watchstander/maintainer. To perform the necessary analyses, process-modeling tools have been applied to the CVNX program, and task network simulation tools have been proposed for application to DD 21. In both cases, the proposed tools require fairly extensive knowledge of the sequential or network properties of the operator and maintainer tasks. This knowledge is seldomly available in the concept definition and exploration phase. At their best, these tools require labor intensive and time-consuming data collection efforts.

The tool to be developed should be specifically tailored for use in the concept exploration phase of the system acquisition cycle. It will permit rapid approximations of workload and manning requirements, and the potential for maintaining situation awareness and tactical perspective of competing system design or automation concepts. The rapid workload analysis element of the tool should utilize a small number of task and activity parameters, such as mean duration, task frequency, manloading, and other conditioning factors. The intent should be that the parameter sets will be amenable to rapid definition using subject matter expert (SME) inputs regarding predecessor systems, and modification of these parameter sets for alternative concepts using human role definitions rather than explicit manned stations or NECs. The tool should include a database of typical shipboard watchstander and maintainer tasks with representative parameters and parameter estimation guidance. A simplifying factor that reduces the number of free parameters to be estimated for a given concept is that for many shipboard tasks, the task frequencies will be defined or constrained by the use of mission scenarios. These scenarios will contain events, such as multi-track engagements or equipment failures, which call for certain functions in the model to be performed. Therefore, the frequencies of certain tasks will be amenable to estimation from the scenarios.

Mission scenarios should also be used to determine the potential for successful task performance under conditions of tight time constraints and high information loads. The human performance element of the assessment tool should focus on the extent to which a design concept facilitates or impedes human performance for a selected scenario. The tool should contain a data base of typical shipboard tasks with indications of HSI problems identified in existing ships and existing implementations of ship systems, with emphasis on the cognitive aspects of these tasks, such as short term memory, information integration, decision making, situational awareness, and maintenance of tactical perspective. The range of HSI problems catalogued should include human performance problems (human error incidence, excessive time to perform, excessive cognitive workload, etc.), safety problems (hazards and accident rates), and health problems (incidence of ergonomic injuries, heat or cold stress, noise effects, etc.).

PHASE I: Define the software and user-computer interface (UCI) requirements and identify the host application under which the tool will run. The host should be generally available to prospective users. Define example scenarios, conditions, functions, tasks for a representative ship and its representative systems. Develop a model of user-tool interactions and transactions in representative tool use situations.

PHASE II: Develop version 1 of the software and beta test this prototype using input from representative end users. Modify the software accordingly. Define a set of representative systems, missions, scenarios and functions and populate the function/task database. Develop guidance for estimation of function/task parameters by applying the software and data to a representative competing concept evaluation. Produce user guide documents.

PHASE III: Produce and market the software and make it available to suitable Navy agencies and contractors, and promote the use of the workload/manpower analysis tool in concept evaluation efforts within selected acquisition programs such as DD 21.

COMMERCIAL POTENTIAL: The workload analysis tool will be applicable to any business process re-engineering initiatives involving manpower optimization or the analysis of manpower requirements based on operator/maintainer workloads

KEYWORDS: Manpower; Workload; Human Systems Integration; Human Reliability; Health and Safety Computer Tool.

N01-116 TITLE: Embedded Training in an Optimized Manning Environment

TECHNOLOGY AREAS: Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: DD-21

OBJECTIVE: Develop and demonstrate a methodology for conducting embedded training in optimized manning environments aboard naval ships.

DESCRIPTION: Future Navy ships will be operated and maintained by significantly fewer sailors. Increasing use of automation, along with improvements in system reliability are behind this trend. The next generation of surface ships will increase their use of reliable automation resulting in the reduction of the number of personnel required to maintain and operate warfare/warfare-support systems. This reduction in manning results in fewer people requiring training, fewer trainers, and the training required involves learning details of complicated systems. It becomes apparent that embedded/tightly-integrated training will be required. However, embedded training, to be effective, must correspond and respond to the new manning environment. The effects of this new environment on training, particularly embedded training methods and systems, are not well understood. Team and proficiency maintenance training in this reduced manning environment will require new methodologies, since both the number of operators being trained and the training personnel available to conduct training will be reduced. Current embedded training capabilities, such as the Advanced Embedded Training (AET) system and the ongoing Synthetic Cognition for Operational Team Training (SCOTT), need to be extended to ensure individual competencies and supporting team behaviors can be assessed, deficiencies diagnosed, and training executed within the lifelines. The research and methodologies generated by this SBIR will lay the foundation for new training paradigms that will be effective in this type of environment.

PHASE I: Research individual and team training requirements for a reduced-manning Combat Information Center (CIC). Design, develop, and document a methodology for conducting scenario-based training, dynamically assessing team performance, providing real-time feedback, and automatically generating tailored training for identified deficiencies. With manning reductions of 70% targeted for DD 21, a commensurate reduction in training personnel must also be targeted.
The AET program demonstrated a 50% reduction in trainer resources for training execution. This was combined with methodologies that improved teamwork performance by over 30%. However, these advances must be improved and address not only training execution but planning, debrief, and post-exercise remediation. This methodology must include the ability to rapidly generate training scenarios, archive individual and team performance profiles, associate observed behaviors to approved training metrics, and automatically generate individual and team training recommendations. In addition, the training methodology must accommodate both trainer-augmented and trainer-less scenario-based training sessions.

PHASE II: Develop a prototype of the system described in Phase I. Develop a detailed design document for the embedded training prototype. Corresponding guidelines or instruction manuals should also be developed and documented.

PHASE III: Produce and market the final system design. Develop design(s) for implementation into other shipboard teams and other ship classes (CVN, LPD-17, etc.).

COMMERCIAL POTENTIAL: This methodology will have applications to military, government and private sector organizations in which high performance skill retention and/or a high degree of cross training is applicable.

REFERENCES:

1. Chief of Naval Operations (N86) Operational Requirements Document for Land Attack Destroyer (DD-21) dated 3 December 1996.
2. Cannon-Bowers, J. A. & Salas, E. (1998) Individual and team decision making under stress; Theoretical underpinning. In J. A.
3. Cannon-Bowers & E. Salas (Eds.), Making Decisions Under Stress: Implications for Individual and Team Training. (pp. 17-38). Washington, DC: APA Press.
4. Dwyer, D. J., Oser, R. L., Salas, E., & Fowlkes, J. E. (1999). Performance measurement in distributed environments: Initial results and implications for training. Military Psychology, 11(2), 189-215.
5. Stretton, M. L., Johnston, J. H. & Cannon-Bowers, J. A. (1999). Conceptual Architecture for embedded team training management. Human/Technology Interaction in Complex Systems, 9, 87-120.
6. Oser, R. L., Cannon-Bowers, J. A. Salas, E., & Dwyer, D. (1999). Enhancing human performance in technology rich environments: Guidelines for Scenario-Based Training. In E. Salas (Ed.), Human/Technology Interaction in Complex Systems, (pp. 175-202).
7. "Decision Making in the AEGIS Combat Information Center," Hall, J. K., et. Al., I/ITSEC Proceedings, 1998.

KEYWORDS: Onboard Training; Embedded Training; Training Systems; Training Methodologies; Team Training; Scenario Based Training

N01-117		TITLE: Non-Lethal Ship Defense Response Systems (Anti-surface)

TECHNOLOGY AREAS: Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: DD-21

OBJECTIVE: Develop and demonstrate non-lethal anti-surface ship defense weaponry that is compatible with and can be successfully employed in a shipboard environment with minimal impact to current ships. At a minimum, weaponry should provide sufficient deterrent “barrier” capability to permit a ship’s crew to readily distinguish a determined adversary from a straying civilian.

DESCRIPTION: Surface ships, including surfaced submarines, are most vulnerable to unconventional attack when they are anchored, pier side, or forced to transit narrow chokepoints such as the Strait of Hormuz or the Suez Canal. Current technology forces commanding officers to rely on manpower intensive use of picket boats and sentries who have only pyrotechnics, fire hose, or small caliber live warning shots to fend off approaching persons or surface craft of unknown intentions. These methods are not only slow and burdensome in employment but they may also harm the straying innocent civilian. They are also unlikely to adequately slow or otherwise permit identification of a determined adversary at ranges sufficient to permit employment of lethal force. Ship commanding officers require a non-lethal defensive mechanism that are employable from current ships, in port and underway, and involve minimal manpower. Application would be against approaching persons or surface vehicles, both land and waterborne. The mechanism need not completely disable a suspect person or vehicle; it must only provide sufficient discomfort and deterrence such that only a dedicated enemy would persist in advancing or continuing actions. Its use must not result in permanent injury. It would be highly desirable if the compactness of the technology would permit employment from small watercraft and SH-60 class helicopters. Candidate technologies might include a combination of high velocity water cannon, eye-safe laser dazzlers, high intensity acoustics, pulsed power and directed energy devices. All such mechanisms must be able to withstand the rigors of the shipboard environment, be near instantaneous in reaction time, and variable in intensity such as to provide initial effects at 300 meters and effective deterrence at a range of 150 meters without adversely effecting own ship crew, ship systems or the environment.

PHASE I: Develop and vet SBIR test scenarios, objectives, and requirements. Develop and demonstrate selected technology(s) to 100-meter range in static test environment.

PHASE II: Integrate selected technologies if required. Demonstrate effectiveness of selected technologies in simulated shipboard environment to 150-meter range under all test conditions. Demonstrate safety features. Collect, analyze, and present test data.

PHASE III: Install prototype system on test vessel of Navy choice for 6-month evaluation period. Collect, analyze, and present reliability, maintainability, and availability data.

COMMERCIAL POTENTIAL: This technology has wide application in both government and commercial security business (high value site protection) and in law enforcement (non-lethal weapons/crowd control).

REFERENCES:
1. USS Cole investigative report (in progress).
2. DD21 Design Reference Mission (DRM) environmental conditions.

KEYWORDS: Non-lethal weapons; ship defense; counter terrorism weapons; unconventional weapons; barrier defense; trip wire.

N01-118 TITLE: Surveillance of Ship Security Perimeter While in Port

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: DD-21

OBJECTIVE: Develop and demonstrate a surveillance system to monitor personnel and small craft activities around the security perimeter of naval vessels while in port. The system must be able to detect and track the movements of non-authorized personnel/craft within the security perimeter. The system should incorporate a knowledge-base of procedural and intelligence issues tied to surveillance data to discern movement patterns that will be used to recognize non-authorized personnel/craft. In addition, the system should work in conjunction with auxiliary sensors to identify authorized versus non-authorized personnel. The perimeter monitoring security system will perform security surveillance, detection and tracking activities. Its control interface will be simple to operate and located in in-port manned watch stations areas convenient to shipboard security personnel. Once identification has been made, surveillance system interface with non-lethal devices should allow deployment of the device at crew's discretion in response to various threat conditions.

DESCRIPTION: A perimeter monitoring security system can be developed to provide dockside and adjacent water coverage for detection and tracking of unauthorized personnel or vessels within a ship's security perimeter. Simulations should be developed to evaluate the performance of the candidate surveillance systems for their ability to provide appropriate detection coverage capabilities such as clutter mitigation and probability of detection for land-based and water-based targets. The program will require the development of software that will be able to identify non-authorized personnel along a dockside and water perimeter, and track their movements inside a security perimeter. A n easy-to-use perimeter monitoring security system will be developed which will display, on a dedicated security monitor, the current location and track history of all non-authorized personnel within the ship's security perimeter. The system will also provide visual and auditory alarms of all security perimeter breaches. The perimeter monitoring security system should coordinate with other shipboard security sensors such as Low-Light TV/Forward-Looking Infra-Red (FLIR), CCTV, and motion sensors for additional coverage and identification capabilities. The prototype perimeter monitoring security system should be a stand-alone, PC-based system. It should not interfere with other ship radar activities or other security operations.

PHASE I: Develop a system concept including sufficient detail to convey physical and performance characteristics. Evaluate existing surface-search/navigation radar systems for their suitability in the detection and tracking of humanƒ{sized targets in a port area. Analyze the dynamic clutter environment of coverage areas in sample ports, determine the probability of detection in those areas, and develop initial clutter models for this environment. Phase I also will include tie-ins to existing C3I systems and evaluation of existing supplemental sensor systems such as Low-light TV/Forward-looking Infra-Red (TV/FLIR) sensors.

PHASE II: Develop a prototype of the perimeter monitoring security system. The monitoring system shall be able to detect, track and identify nonƒ{authorized personnel who breach the land and water perimeter. The perimeter monitoring security system shall have a user-friendly interface and require minimal training to operate. During this phase, the prototype system will be evaluated in sea port trials.

PHASE III: Develop perimeter monitoring security system specifications and begin production of security systems for widespread distribution to the fleet.

COMMERCIAL POTENTIAL: Technology developed for ship perimeter monitoring will transition easily to perimeter monitoring of other assets, including large land areas of military bases and commercial properties.

KEYWORDS: Surveillance Radar, tracking algorithms, radar cross section, clutter, probability of detection, perimeter security

N01-119 TITLE: Simulation Environment in Support of Non-Cooperative Target Recognition (NCTR) Algorithm Development

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: DD-21

OBJECTIVE: To develop and demonstrate a software/hardware simulation environment concept in support of Radar/IR NCTR algorithm development effort. The simulation environment must be capable of providing realistic and repeatable sensor measurements against specific targets in specific geometries and external environments in realistic processing times, with interfaces that are manageable by typical users.

DESCRIPTION: The NCTR problem is one of the most complex issues facing the Navy within the context of air and space defense. Within the area of air defense, shipboard sensors may be tasked in discriminating among many complex targets, which may contain any mixture of friendly, neutral, and hostile populations. To increase the probability of correct identification, and minimize the probability of incorrect identification, multiple sensors may have to be employed, and from more than a single platform. This topic is concerned with the specific combination of radar and infrared search and track (IRST) sensors, operating from a single platform. Since the discriminates in questions may be complex and varied, developing the required algorithms will necessitate the availability of high fidelity sensor, target, and environment modeling tool, representing both radar and IRST, which will account for the different sensors and their operating modes, changing environments – including clutter, propagation, sea, and terrain – target particulars, and relative geometries. The function to be served by such a simulation cannot be fully served by field measurement since field measurements (a) are expensive to obtain, (b) cannot be taken with notional sensors, (c) cannot cover all geometries, environments, and threats in question, (d) do not always provide precise knowledge of the geometries prevailing at the time of the measurement, and (e) are not repeatable. Whereas the role of the simulation environment is to resolve fundamental issues, help support the algorithm development, and provide vigorous exercising to the techniques, the role of field measurements is to provide the final validation to already developed algorithms.

PHASE I: Develop a simulation concept in support of NCTR technique development based on the combination of radar and IRST sensors. Define the required architecture, including provisions for growth; identify the necessary software/hardware components; and classify such components by availability vs. need to develop or extend.

PHASE II: Construct a simulation prototype and validate its outputs via comparison with limited live test data. Demonstrate the utility and growth potential of the simulation prototype via relevant examples of its use.

PHASE III: Insert the capability in a non-SBIR Navy program in support of air threat radar/IRST NCTR algorithm development activity. Support the evolution of the tool through on-going synergy with the NCTR algorithm development program. Study the potential contribution of additional sensors – co-located or from distributed platforms - to the NCTR performance, and expand the simulative tool accordingly.

COMMERCIAL POTENTIAL: The resulting tool should have multiple users within all of the military communities concerned with NCTR issues – i.e., Navy, Air Force, and Army.

REFERENCES:
1. Xpatch/Npatch/FISK SAIC/DEMACO References
2. Clutter Modeling References
3. Radar Modeling and Simulation References
4. IRST Modeling and Simulation References

5. Propagation Modeling References

KEYWORDS: Simulation; Target Signature; Sensor; Environment; Propagation; NCTR; Radar; IRST

N01-120 TITLE: Global Positioning System (GPS) Jamming Situational Awareness for Naval Surface Fire Support (NSFS)

TECHNOLOGY AREAS: Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT II - Extended Range Guided Munition [ERGM]

OBJECTIVE: Develop technologies that will provide users of Naval Surface Fire Support (NSFS) weapons such as the EX 171 ERGM situational awareness of the GPS jamming environment. These technologies will provide the ability to measure jamming or interference of the Global Positioning System (GPS) signals, assess how the jamming will affect the weapons, and take actions to reduce the impact of jamming.

DESCRIPTION: New weapons for Naval Surface Fire Support, such as the EX 171 ERGM, use GPS as their primary means of navigation. The projectiles also carry inertial instruments that are aligned and calibrated by GPS early in the mission, to provide back-up navigation if GPS is later jammed. The inertial instruments also provide inertial aiding of the GPS, increasing its anti-jam performance. The projectile also has multiple GPS antennas, which permit it to null the signals from a small number of jammers. But these weapons have a limited number of antennas and a low goal for production cost, and so are not invulnerable to GPS jamming. This topic seeks technologies that will help ships firing NSFS missions to measure the GPS jamming and interference environment, predict how this environment will affect weapon performance, and take action to best employ the weapons in the face of jamming.

The system should be able to combine organic and off-board sensors to measure jamming levels, characterize the jamming signals (for example, narrowband vs. wideband, and directional vs. omnidirectional) and geographically locate the signals with enough accuracy to predict their effect on the weapons' receivers. Organic sensors can be deployed in gun projectiles (free-flying or as a parachute payload), with weather balloons, or using the Forward Air Support Munition. (FASM is an expendable gun-launched aircraft under development, capable of carrying a payload 4.5 inch in diameter and 20 inches long and flying for three hours, although a smaller payload would be desirable, to allow it to be carried along with other mission payloads.) The cost of expendables must be kept low, to be compatible with the weapons costs themselves. (NSFS must be affordable, and resources applied to understanding the GPS environment must be balanced against improved anti-jam capability in the weapon, or the use of more expensive weapons like Tomahawk.) The ability to incorporate off-board sensors such as signals intelligence aircraft is valuable, but the system must be able to operate using organic assets only, and not depend on scarce manned aircraft or large UAVs.

The predictive capability should include the following features:
1. Predict, for a given weapon and class of target, the effectiveness of the weapon (based on both the probability that the weapon may not acquire GPS initially, and the loss of accuracy resulting from loss of GPS later in flight.)
2. Compare the differing impact of jamming on different versions of the weapon and different weapons. (Later versions of a weapon may include better anti-jam equipment or different navigation instruments).
3. Account for the impact of different trajectories that may be available to the weapon.
4. Assess the ability to carry out multiple-round-simultaneous-impact firings (a tactic where multiple rounds are fired at the same target, with earlier round fired on trajectories that have longer flight times, so all rounds arrive at about the same time.)
5. Examine alternative of ship stationing and offset firing to improve anti-jam performance. This capability will allow ship commanders to improve their weapon performance by repositioning their ship.

PHASE I: Develop a system approach for GPS jamming situational awareness, and establish critical technologies needed to implement this system. Conduct critical field experiments or bench-scale tests if needed to establish the feasibility of the approach. Assess the performance of the approach in a simulation.

PHASE II: Develop the key technologies identified in Phase I. Fabricate, test, and evaluate them in a stand-alone prototype of the system designed in Phase I

PHASE III: Integrate the prototype system into the shipboard combat system as a tactical decision aid. Near-term integration will be into the Naval Fires Control System, which itself is being integrated into the Aegis Combat System.

COMMERCIAL POTENTIAL: As GPS becomes a greater part of civil aviation, commercial surveying, and time synchronization of wireless data networks, the necessity for users and government agencies to quickly locate sources of interference to GPS is growing. This system will provide such a capability to the FAA, the FCC, and the end users. More generally, the technologies developed will also be applicable to location of other sources of radio interference.

KEYWORDS: Global Positioning System, jamming, interference, situation, awareness, environment

N01-121 TITLE: Non-GPS Projectile Navigation

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT II - Extended Range Guided Munition [ERGM]

OBJECTIVE: Proved an alternative navigation approach for guided projectiles, to provide for situations where the GPS signal is unusable because of enemy jamming.

DESCRIPTION: GPS jamming is a significant threat, and countering jamming is the focus of substantial research, development, test, and evaluation effort. GPS-guided weapons, including projectiles, incorporate anti-jam features that go far to mitigate this threat. However, a determined enemy can still jam GPS. This is a particular concern for developers of gun projectiles, because the projectile is designed as a “wooden round” with a 20-year shelf life. Projectiles are bought in a large lot and stored with no maintenance and no opportunities to backfit improved antijam features. Gun projectiles are expected to be low cost, and it is not feasible or cost-effective to pull projectiles from inventory, disassemble them (with due regard for their explosive warhead and energetic rocket motor), and install upgrades. For this reason, the NSFS program desires that projectiles contain an approach to navigation that is independent of GPS, and can function despite the best effort of an enemy 20 years in the future to jam GPS.

PHASE I: Develop an approach to navigating in a jamming environment that makes GPS totally unavailable. (GPS anti-jam approaches are not desired in this topic. Neither are GPS signal augmentation and “pseudolites” approaches, since theses are already being developed in other efforts and additional work in this area is not desired). The most important requirement for the approach chosen is that it fit inside the projectile, in all ways. That is, it must physically fit, it must function in the projectiles environment including surviving gun launch, and it must fit the projectile’s cost budget, adding no more than about $5000 to the cost in production quantities of 10,000 units. After this constraint, it is desired to minimize the external support required to permit non-GPS navigation. So, an approach that reduces the need to deploy or survey-in base stations is desirable, as is an approach that uses cooperative or non-cooperative signals of opportunity. (The jammers themselves can be used as signals of opportunity, but with due consideration for the difficulty in “surveying in” these emitters.) Finally, within these constraints, accuracy comparable to GPS is desired, with degradation to 50 meters CEP allowable if necessary. In Phase I, the contractor should demonstrate the feasibility of the proposed concept through analysis, simulation, and conduct of critical experiments. Critical experiments should show that the observable that the navigation system measures can in fact be detected and measured by the projectile with sufficient accuracy to support navigation.

PHASE II: Develop a prototype of a navigator that uses the approach demonstrated in Phase I. Characterize its performance, and determine the operational conditions under which it will and will not function properly. The prototype need not be miniaturized to fit in a projectile but there must be a clear path to a projectile-sized navigator. The design and prototype may assume the projectile has a GPS receiver including frequency reference and antennas, low-grade inertial navigator, flight control computer, power, and digital interface for initialization; development effort should focus on components beyond this baseline. To ensure low cost and small volume, approaches that reuse much of the GPS receiver, and approaches that are based on a large-volume commercial production base, are encouraged.

PHASE III: The navigation capability developed by the contractor would be used in the EX 171 Extended Range Guided Munition and in the projectile for the Advanced Gun System, with additional applicability to the Army XM 982 “Excalibur” and Navy Advanced Land Attack Missile.

COMMERCIAL POTENTIAL: The navigation technique developed in this topic will have applicability to the following areas:
1. Very low cost navigation in devices that already receive a non-GPS signal, such as portable telephones, wireless data devices, and instrumentation systems
2. Backup or cross-check to GPS for safety-critical installations.
3. Navigation in areas not well-covered by GPS—indoors, in urban “canyons”, or in open-pit mines.
4. Ground-truth for testing of GPS systems, especially conducting tests that assess susceptibility of commercial GPS systems to interference.

KEYWORDS: Navigation, GPS, ranging, jamming, accuracy,

N01-122 TITLE: Modeling High-Temperature Erosive Gas Flow to Support Barrel Erosion Reduction Concept Modeling for Fire Support Gun Application

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT II - Gun Weapon Systems Technology program

OBJECTIVE: Develop the modeling and analysis tools needed to implement erosion-prevention technologies. These tools will be used to explore new concepts of barrel materials, coatings, linings, rifling, and interior geometry and their interaction with high-energy, high-temperature propellants and high firing rates. They will be applied to upgrades to existing guns such as the Mk 45 5-inch gun, and to the new 155-mm Advanced Gun System for DD 21. The tools will allow these programs to select and justify the correct combination of technologies to extend the erosion-limited life of the barrel, while having a minimum impact on operational utility (such as the ability to fire both spin-stabilized and despun projectiles), ease of fabrication, and barrel fatigue life.

DESCRIPTION: Next generation high energy guns, for reasons of efficiency, range, and cost will fire projectiles with fast burning, densely packed, high temperature propellants. These propellants will allow guns to produce 80 to 100% more muzzle energy than using today's propellant technology. Unfortunately these performance improvements come at the cost of higher propellant gas temperatures. Current known propellant chemistries all produce higher internal energy along with p-V, work energy. Traditional methods of formulating a propellant with a cooling agent of some sort are limited because of the need to maintain high overall energy density. Additionally, high loading density geometries, which increase muzzle energy even more effectively than high-energy chemistry, place even greater heat loads on the barrel.

Currently, barrel designs that incorporate refractory or ceramic-like materials are being considered to remedy this situation. All these concepts can be expected to require a considerable investment in new material and manufacturing technologies. What is being sought in this topic is the development of a high-fidelity computer modeling tool that draws on state-of-the-art coupling of computational fluid dynamics and finite element modeling, incorporating results from the data analysis of ongoing government development efforts, plus any key experiments the contractor requires. This modeling tool will then be used to compare and assess the gains in erosion life resulting from various combinations of innovative erosion-reduction technologies applied to the Mk 45 Mod 4 and the Advanced Gun System (AGS). It is expected that through a host of unexplored design solutions such as geometry changes in barrel hot sections, rifling profile modifications with accompanying obturator designs, hot section surface coatings, and boundary layer additives that the near-term need of improving the Mk 45 Mod 4 erosion life by 100% can be met.

PHASE I: Create a physics-based parametric model of the gun barrel erosion process and calibrate it against a GFI data set based upon actual test firing and rocket nozzle erosion experiments. (The Naval Surface Fire Support program is currently conducting firing tests to assess the erosion problem and develop near-term solutions. Phase I and Phase II of this SBIR will have access to this data.) The model should account for effects such as barrel material and coatings, propellant properties of impetus and flame temperature, and gas flow and boundary layer effects. The model should be focused on representing the operating regime of 5-inch and 155 mm Naval guns, with sufficient scope for growth so that the model is a forward-looking tool that will support innovations and improvements to these guns. Validate the model against additional GFI data and against a higher-fidelity (but less easily used) modeling approach such as a first-principles computational fluid dynamic (CFD) analysis of current Mk 45 Mod 4 rifled and smooth bore gun tube. This validation will both show the correctness of the implementation of the parametric model, and will provide a first look at its utility as a tool for understanding the causes of erosion and for developing engineering fixes to problems.

PHASE II: Create a first-principles computational fluid dynamics code that predicts barrel erosion predictions in Mk 45 and AGS gun systems. Because boundary layer and turbulent flow effects are believed to be critical contributors to erosion, this code must accurately model these effects in two dimensions. However, the erosion predictions need only be 1-D results, estimating the severity of erosion at stations along the length of the barrel. The physical and thermal model of the barrel must be able to support steel barrels with linings or coatings that have thermo-chemistry very different from steel. This model shall be calibrated against the Phase I experimental data and against other physically based models in ab initio calculations. The model should be suitable for erosion-limiting design concepts in the existing Mk 45 Mod 4 gun system. So, it should be able to simulate firing of 40, 100, and 150 pound projectiles (representing the Barrage Round demonstration projectile, the Extended Range Guided Munition (ERGM) and the "Best Buy" demonstration projectile). These simulations should be at 18 to 25 MJ of muzzle energy, with proposed Navy propellant thermo-chemistries having maximum propellant flame temperatures of 3600 K.

PHASE III: The code developed in this SBIR shall be transitioned to interested contractors to aid them in evaluation and design of erosion reduction schemes, to government laboratories for the evaluation in barrel lifetime and wear investigations, and to the procurement process to improve the process of setting meaningful specifications, identifying MANTECH issues, and aiding the design evaluation process in this area.

COMMERCIAL POTENTIAL: Advanced thermo-chemical modeling in high temperature, high pressure, high carbon/ hydrogen atmosphere is directly applicable to thermal erosion problems in most internal combustion engines utilizing hydrocarbon fuels. The higher operating temperatures and pressures of guns represent the range of operation that higher efficiency engines are already moving toward. Special coatings and shapes such as are being modeled here will be directly applicable to next generation, hotter, high efficiency engines.

KEYWORDS: Computational Fluid Dynamics, Thermal Erosion, Thermo- Structural, Thermo-chemical, Gun, Rifling

N01-123 TITLE: Wireless Audio/Video Headsets

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: PEO Aircraft Carriers

OBJECTIVE: Develop and demonstrate wireless, full-motion, two way un-tethered, lightweight, portable audio/video headset compatible with existing aircraft carrier wireless interior communication systems (includes flight deck). Build a prototype and production model to demonstrate/field this capability.

DESCRIPTION: A need exists to provide wireless full motion, two way un-tethered audio/video in US Navy utilizing the existing interior wireless communications (includes flight deck) Radiating Transmission Line (RTL) as a wireless LAN with an interface to the ship's video Tele-conference (VTC) and exterior communications equipment. This capability would provide distant mobile Tele-Medicine, Tele-Maintenance, and damage control search & rescue in smoke and darkness. Develop recommended policy, procedures, specifications, and other required guidance to provide a selection process for addition of system on the wireless LAN. This is required to ensure configuration management, spectrum support, power level requirements, interoperability with existing systems, notional design, audio levels, video resolution, radio frequency environment, and Electro-Magnetic Interference (EMI), within the RTL and within the ship. Determine hardware requirements including interface hardware, recording equipment and all logistics support (parts, manning, and training) to implement on board aircraft carriers. Areas of risk include radio frequency environment, and Electro-Magnetic Interference (EMI) within the RTL and within the ship, capacity of Hydra RTL antenna to support multiple wireless devices, lack of spectrum support, Infra-Red spectrum, human factors interface (equipment weight, battery life, ease of operation).

PHASE I: Feasibility demonstration. Develop recommended policy, procedures, specifications, and other required guidance to provide a selection process for addition of this and similar systems on the wireless LAN. Design and conduct a feasibility study in a US Navy aircraft carrier. Determine spectrum support, power level requirements, interoperability with existing systems including the ship's VTC and Damage Control Self Contained Breathing Apparatus (SCBA), notional design, audio levels, video resolution, model the radio frequency environment, Infra-Red detection, and Electro-Magnetic Interference (EMI), within the RTL and within the ship (includes flight deck). Determine recording equipment requirements. Develop test procedures to determine that the engineering design meets or exceeds the requirements for operation throughout an aircraft carrier with a Hydra Block II RTL antenna system when the prototype is tested in phase II. The Phase I final report should include an analysis of alternative concepts as well as an assessment of cost.

PHASE II: Application demonstration. Design and develop a compatible wireless full motion, two way un-tethered audio/video into a suitable headset prototype device. The prototype should be lightweight, less than 15 oz. and user friendly. Design and develop the interface hardware to the ship's RTL antenna and the VTC equipment. Demonstrate the prototype headset, interface and recording equipment on an aircraft carriers RTL antenna system. Document all lessons learned for analysis and improvements during phase III. Provide a detailed engineering report of this testing. The Phase II final report should include an execution plan for Phase III, including cost and schedule.

PHASE III: TRANSITION TO PRODUCT DEMONSTRATION. Design and develop the production model headset, interface hardware and recording equipment. Develop full logistics support requirements (parts, manning, training) to implement on board aircraft carriers in accordance with NAVSEAINST 9083.1 (series) and other Navy guidance. Develop an implementation plan including estimated cost to procure/install on board aircraft carriers. Develop other appropriate Navy documentation to support a Navy program of record as required.

COMMERCIAL POTENTIAL: The commercial derivative of this device would have widespread application in public safety.

REFERENCES:

1. AN/SRC-55 HYDRA COMMUNICATIONS SYSTEM
2. NAVSEA DRAWING 53711-409-7338847
3. AN/SRC-55 Operational Requirements Document 430-06-96 dtd Mar 1966
4. Technical Manuals – COMMNET ERICSSON EDACS COMMUNICATIONS SYSTEM

KEYWORDS: Interior Communications; Wireless Video; Damage Control, Tele-Medicine, Tele-Maintenance

N01-124 TITLE: Advanced Power Distribution Systems

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT ID

OBJECTIVE: Develop and demonstrate an improved power distribution system that is more survivable, reduces equipment volume and weight, while reducing electric equipment outages during electrical system anomalies. The distribution hardware in presently configured systems utilizing solid state power supplies in the less that 50 kVA range does not provide the necessary electrical protection during short circuits. A new solid state distribution system should increase the electrical system survivability during system anomalies by providing improved fault detection time, improved fault isolation time, and a reduction in the interruption of power to unaffected electrical loads.

The function of the advanced power distribution system is to: (1) receive power from a power source; (2) distribute power to various power consuming loads via a solid state power controller; and (3) protect power consumers from system anomalies. The system will have to: (1) perform these functions over an acceptable long period under typical operating and environmental conditions; (2) have an operator interface; (3) interface with electrical power sources, loads, and digital communication systems; and (4) have various mechanical interfaces.

DESCRIPTION: The science and technology investment strategies have identified a need for technology development in the area of power and automation. The specific focus includes advanced electrical systems in the area of power distribution concepts, which are highly survivable and provide uninterruptable electrical power. Present electrical systems are being modified through the increased use of uninterruptable power supplied in small, distributed, radial designs. To ensure survivable and uninterruptable power during anomalies such as short circuits, the electrical protection system must ensure continuity of the electric power supply by isolating damaged sections of the system. Uninterruptable power supplying small (such as 5 kVA, 10 kVA, 15 kVA) systems are in a radial configuration.

The primary low voltage (nominal 120 vac), overcurrent and short circuit protection device utilized is the Navy ALB-1 circuit breaker manufactured in accordance with MIL-C-17588. Utilization of 5 kVA, 10 kVA, 15 kVA uninterruptable power supplies does not provide enough short circuit current to trip the larger size ALB-1 circuit breakers during short circuit conditions. Failure to "trip" circuit breakers supplying loads during these short circuit conditions will cause power supplies to shut down under overcurrent conditions and will secure power to all the loads being supplied by the power supply. The development of a low power electronic power controller will substantially improve overcurrent and short circuit protection of low voltage and low power systems by replacing electro-mechanical devices with non moving, silent operation electronic devices. The notional distribution system would be a new power panel consisting of: an enclosure; thermal management system; backplane used to receive and distribute power; plug in electronic power controller consisting of multiple single pole electronic switches mounted on circuit card assemblies; and control/power management/intelligence to allow manual and automatic settings. A secondary advance will be the development of an integral circuit breaker/motor starter. This device will provide overcurrent, short circuit, motor starting capabilities and will replace two pieces of equipment with one, thus reducing equipment and cable installation.

The system must operate within typical natural and induced environments such as high shock (MIL-S-901), vibration (MIL-STD-167-1), electromagnetic interference (MIL-STD-461), ambient temperatures ranging from 0 to 50 degree C, humidity ranging from 0 to 100% including conditions wherein condensation takes place in or on the equipment, and inclined up to 45 degrees from the vertical in any direction. The operator should be able to interface locally and remotely (via a communication port). Local control and indication should be included. The electrical power interfaces are described in MIL-STD-1399, Section 300A. Communication to external control and monitoring systems should be in accordance with industry methodologies and standards. Mechanical interfaces include physical mounting as well as connections to typical copper conductor cables having 90 degree C insulation systems.

The power controller should mimic the performance of electro-mechanical circuit breakers, thermal relays, fuses, and motor controllers. The function of the calibrated, resettable power controller is to: (1) operate as a configurable / adjustable / intelligent sensing device; 2) operate as a independent switching device (on/off); (3) operate as a automatic high speed (less than 8 millisecond including fault detection and interrupt time) circuit interrupter by interrupting abnormally high operating currents or short circuits; and (4) operate as a motor controller.

The control, sensing, and intelligence function of power controller is to: (1) configure the system via a control management function to allow for the switching devices to operate as multiple single pole devices, multiple two pole devices, and/or multiple three pole devices; (2) interrogate voltages and currents through the device; (3) make informed decisions based on user inputs/settings, time vs. current characteristics, di/dt characteristics (change in current with respect to time), and/or artificial intelligence techniques; and (4) provide trip commands to the interrupting device upon exceeding adjustable thresholds. Short circuit current conditions warranting an instantaneous “trip” signal to the interrupting device should be made within 7 milliseconds (design goal of approximately ½ 60 Hz cycle) of the fault inception. Adjustable thresholds include: (1) continuous current operation (adjustable from 0.1 to 50 amperes); (2) instantaneous current trip (adjustable from 1 to 1500 amps); (3) short time current trip (adjustable 1 to 1500 amps); (4) long time current trip (adjustable, 100% to 125% of continuous current setting; and (5) adjustable time delay to prevent nuisance tripping or improve coordination with other devices (such as 30 to 120 milliseconds with +/- 5 millisecond tolerance). The unit must be capable of operating in overcurrent conditions, not be affected by non linear loading conditions (including 6 pulse rectified loads) and preventing nuisance tripping upon power up conditions (such as inhibit temporarily the instantaneous trip function on a power controller "turn on", or inhibit function when no or low current has been present but an inrush of current is sensed indicating a remote device being turned on).

The switching device function is accomplished through the use of multiple single pole solid state devices nominally rated at 50 amps continuous operation at 50 degrees C without overheating. The device should have an endurance and a reliability that exceeds circuit breaker and contactors of similar rating and size. Along with operation as a switch, the device should operate as a circuit interrupter.

The circuit interrupting device function should operate in conjunction with the control/sensing/intelligence function. The device should interrupt average three phase symmetrical currents up to 1500 amps (assuming an X/R value of 6.6, design goal should be 5000 amps at same X/R ratio). In later versions of the power controller, the device should also integrate motor controller functions. In the motor controller mode, the device must act as a switch (mimic a contactor), overload device (mimic thermal overload protection such as "heaters") and a short circuit interrupter (mimic an instantaneous trip circuit breaker). The device should open or close within 2 milliseconds after receipt of commanded position and open within 1 millisecond of a "trip" command. Local control (on/off/reset) and indication (on/off/trip) should be included with each power controller.

PHASE I: Develop a 125 vac/25 kVA/60 Hz power panel having the innovative design features of completely solid state components, fault tolerant, self diagnostic, low total ownership cost, reliable, maintainable, testable, producible, and based on open systems designs/architectures. In Phase I, develop a detail design (to meet shipboard environmental conditions) of the power panel complete with enclosure, backplane, thermal management, power supplies, circuit interrupting devices, and associated operator interface, and monitoring/control hardware/software. Prototype panel will be fabricated and tested to demonstrate concept feasibility and demonstrate 60% to 80% reduction in short circuit fault detection and interruption time when compared to comparable electro-mechanical circuit breakers. Suggested maximum width should be 15 inches (if practicable). Total volume should be minimized (existing panels are approximately 1900 cubic inches). Total weight should be minimized (existing panel and breakers are approximately 40 pounds total). Fabrication of equipment should include a modular power panel assembly that consists of field replaceable power controller, an enclosure, backplane, field replaceable power supply (for local "house keeping") and operator interface. The power controller should be set of a minimum of three (3) solid state components acting as a single pole device. These three components could be mounted to circuit card assemblies or equivalent. The circuit card assemblies would include the control, power management, and intelligence. The card would be stiffened, would include a back mounted connector that mates to the backplane, have a thermal management interface, and have a mechanical interface with the enclosure. The enclosure should house all associated components (including at least 3 power controllers), allow for mechanical/electrical input and output power connections, allow for remote control via communication port(s), have a mechanical interface to allow for mounting on a wall or bulkhead, and utilize appropriate thermal management techniques. The backplane, mounted within the enclosure, could use advanced bus bar techniques to provide power distribution and circuit interrupter device control connections. The backplane should demonstrate significant advantages in integrating external connections, integrating internal connections, and providing the power controller device interface. A power supply (with a minimum of stored energy to ride through source disturbances) and operator interface to allow for local operation and settings should be provided. The Phase I final report should include an assessment of cost.

PHASE II: Develop nominal 10 circuit, 450 vac/100 kVA/60 and 400 Hz power panel complete enclosure, back plane, thermal management, power supply, integral circuit protection/interrupting/motor starting devices, and associated operator interface, and monitoring/control hardware/software. Interrupt device rating should be increased to interrupt 5000 amps average three phase symmetrical(assuming X/R of 6.6, design goal should be 13000 amps at same X/R ratio). A neutral bus capability should be added to demonstrate 208 volt, 4 wire applications. Total volume should be minimized (existing panels are approximately 2500 cubic inches). Total weight should be minimized (existing panel and breakers are approximately 68 pounds total). Prototype panel will be fabricated and tested to demonstrate concept feasibility. Demonstrate further reduction in short circuit detection and interruption time. Determine the survivability, reliability and reusability characteristics. The Phase II final report should include an execution plan for Phase III, including cost and schedule.

PHASE III: Demonstrate producibility and develop an implementation plan for new production and replace via new design/retrofit application.

COMMERCIAL POTENTIAL: The commercial derivative of the power panel could be developed to support residential, light industrial, aircraft, and pleasure craft applications.

KEYWORDS: Electrical Power; Electrical Distribution; Electrical Protection

N01-125 TITLE: Scale Prevention in Seawater and Freshwater Flushed Shipboard Sanitary Waste Systems

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT ID, PEO Aircraft Carriers

OBJECTIVE: To develop an innovative system or product that can be used to alter or otherwise change the character of flushing water (seawater and freshwater) supplied to shipboard urinals and water closets, in both gravity flush and vacuum flush systems, to reduce scale build-up in collection piping. The performance of the system or product shall be such that no more than 1/16-inch of scale build-up forms in the sanitary waste system piping within a period of six (6) months. To ensure the ability of ships to discharge sanitary waste overboard is not impacted, the system or product shall not significantly change the character of the sanitary waste effluent discharged overboard (i.e. pH and biodegradability) from that of existing ship generated sewage waste. The system or product shall be compatible with the sanitary waste piping systems (Military Specification MIL-T-16420K (SH) and Military Standard MIL-STD-278F(SH) apply) or its components such as valves (Military Specification MIL-V-24509A applies), cast bronze fittings (ASTM B 61-93 applies), and sewage pumps (Military Specification MIL-P-24475 (SHIPS) applies).

DESCRIPTION: Scale build-up in sanitary waste collection piping on Navy ships is a significant maintenance burden on ship's force and shore maintenance activities. Scale forms in both gravity (seawater flush) collection, holding and transfer (CHT) systems and vacuum (fresh water flush) CHT systems. The scale has to be hydroblasted or chemically cleaned out of the piping, which is costly and time consuming. Citric acid scale prevention tablets are currently used for scale prevention. The citric acid tablet provides some relief from scale development (reducing the rate of scale development and changing the form of the scale to a softer easier to remove form), but has not completely eliminated the need to periodically clean scale from piping. In addition, the citric acid tablet is expensive (one tablet per day can be required in a high use urinal) and takes a significant amount of crew time to manually dispense.

A system or product is needed that would significantly reduce or eliminate the formation of scale in the sanitary waste drain lines on Navy ships. Both systems (mechanisms installed in the flushing water or sanitary drain system) and products (tablets, liquids, etc. to be dispensed into the flushing water or drain piping) are acceptable. However, the system or product should be effective at scale prevention, safe for Sailor use, easily dispensed (no Sailor intervention is preferred), required in a minimal quantity to save valuable storage space onboard ship, affordable, and shall not significantly change the character of the waste effluent (e.g. pH, biodegradability, etc.). The goal is to save valuable maintenance time for the Sailors and reduce or eliminate the need to clean scale.

PHASE I: Develop system or product (and dispensing system if required) that will work in conjunction with existing Navy technology to prevent scale development in the drainage piping from urinals and water closets in both gravity and vacuum sanitary systems onboard Navy ships of all sizes. The system or product should require little or no input from the crew and be long lasting so as to require little or no replenishment. The system or product should also be environmentally friendly, in that it causes no additional concerns about discharge of the resultant sanitary waste at sea or pierside. The Phase I final report should include an analysis of alternative concepts as well as an assessment of cost.

PHASE II: Conduct at sea test and demonstration, commencing with shipboard installation of the system or product on all the toilets and urinals (except those toilets and urinals designated as controls for test result comparison purposes) of an active duty Navy platform. NAVSEA PMS307 shall coordinate shipboard installation and test. This installation will be to prove that the system significantly reduces scale build-up and requires no replenishment for at least six (6) months or the time period of a Naval Aircraft Carrier deployment. The Phase II final report should include an execution plan for Phase III, including cost and schedule.

PHASE III: After verifying the effectiveness and compatibility of the system or product with Navy sanitary waste systems, demonstrate its producibility and develop an implementation plan for Fleet wide implementation of the system or product.

COMMERCIAL POTENTIAL: This technology will be applicable to any boat or ship that utilizes seawater or freshwater as a flushing medium. It shall also be applicable to both gravity CHT and vacuum CHT systems. Private boats with water closets should be able to easily install the system or product and not have to worry about scale build-up in their piping. Private shipping lines would be another potential customer.

REFERENCES:
1. OPNAVINST 5090.1B discusses the discharge requirements for sanitary waste systems onboard Navy vessels. The Navy has several documents addressing scale build-up in sanitary waste collection piping.

KEYWORDS: Scale; Sewage; Hydroblasting; Chemical Cleaning; Citric Acid Tablet; Sanitary Waste System

N01-126 TITLE: Advanced Treatment Technology for Shipboard Non-Oily Wastewater

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT ID, PMS 378

OBJECTIVE: To develop a system to treat shipboard non-oily wastewater and provide an effluent stream that is suitable for reuse or unrestricted discharge. The discharged effluent quality should be appropriate for unrestricted discharge in coastal waters (Biochemical Oxygen Demand (BOD5)<30mg/l, Total Suspended Solids (TSS)<30mg/l, and Fecal Coliforms (FC)<200 colonies per 100ml) which meets or exceeds the MSD requirements listed in the reference.

DESCRIPTION: Current Navy ships are designed and built with Collection, Holding and Transfer (CHT) systems that include the tankage required to hold ship-generated sewage for 12 hours. This sizing is based on the maximum expected transit time for the 3 nautical mile (nm) no-discharge, contiguous zone from shore. It is anticipated that effluent quality based on Uniform National Discharge Standards (UNDS) will require that the no-discharge zone be extended to 12 nm, and that graywater (wastewater from showers, galley, scullery, deck drains, laundry and lavatories) generated onboard be treated or held when the ship is in this zone. The holding capacity of existing ships is insufficient to meet the anticipated regulations without wastewater treatment. The most promising technology for treating shipboard non-oily wastewater evaluated to date is the membrane bioreactor (MBR). An aerobic bioreactor is used to pre-treat incoming wastewater so that in-tank membranes can separate solids, bacteria and other contaminants from the effluent stream. The MBR has limitations, including foam control, long-term membrane fouling, and the sensitivity of the biomass to chemical shocks that can occur in graywater drains. In addition, the Navy is demonstrating microwave technology for the incineration of shipboard non-oily wastewater.

An alternative non-oily wastewater treatment process that separates clean effluent from its contaminants without reliance on the MBR may provide a more rugged system that is more easily automated to satisfy reduced manning requirements. Additionally, to support the goal of an environmentally sound ship, reuse of system effluent for technical purposes such as sanitary flushing or equipment washdown would be advantageous. Non-oily wastewater potentially could include certain metals, AFFF, and machinery oils, and the treatment equipment should be capable of handling these constituents without damage to its components or violation of effluent quality limits.

PHASE I: Develop a conceptual design of a system that meets the functional requirements for wastewater treatment of typical navy non-oily wastewater (graywater plus blackwater). System should be able to meet discharge criteria for coastal waters of the U. S. In conjunction with the design, a plan for any subsequent treatment necessary for potential reuse of the treated water should be provided. Reuse would be restricted to technical purposes (i.e., sanitary flushing header, equipment washdown, etc.). The Phase I final report should include an assessment of cost.

PHASE II: Build and test a pilot-scale system that incorporates the critical technologies to prove that the conceptual design works as intended. Conduct pierside testing on actual shipboard waste streams and collect test data to accurately outline a full scale ship system design with the anticipated component sizes, weight, and power requirements, and auxiliary system interfaces. This phase will support development of full-scale equipment for a specific ship application along with the information necessary for the Navy to determine whether to move forward with this technology. The Phase II final report should include an execution plan for Phase III, including cost and schedule.

PHASE III: After verifying the effectiveness of the system and compatibility of the system, demonstrate the producibility and develop an implementation plan for fleet-wide implementation of the system or product.

COMMERCIAL POTENTIAL: This technology will be applicable to any boat or ship that requires wastewater treatment, and should prove to be very efficient from the standpoints of size, weight, and power requirements. It would also be useful in industrial applications where water reuse could increase profitability by reducing required municipality support in water supply and wastewater treatment areas.

REFERENCES:
1. OPNAVINST 5090.1B discusses the discharge requirements for sanitary waste systems onboard Navy vessels.

KEYWORDS: Sewage, Graywater, Blackwater, Treatment, Wastewater, Reuse

N01-127 TITLE: Tactical Sonar Data Fusion

TECHNOLOGY AREAS: Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: AN/SQQ-89A(V)15

OBJECTIVE: Enable sonar analysts to review, integrate, and make rapid tactical decisions based on detection and classification information from multiple undersea warfare acoustic sensors.

DESCRIPTION: The future surface ship Undersea Warfare (USW) combat system will consist of multiple hull-mounted, off-board and towed array sensors providing inputs to multiple active and passive signal processing functional segments. Acoustic sensors will cover a frequency range of over 14 octaves and signal processing segments provide traditional acoustic displays and automated classification data from diverse USW functions, including monostatic/bistatic active, torpedo defense, passive ASW, and airborne sensors. Current implementations provide independent displays for each sensor/processing function and require the sonar analyst to manually synthesize the acoustic scene. Functional segments available for data fusion include; passive acoustic contacts, active acoustic contacts, torpedo like contacts and radar contacts. Sensors available for fusion include hull array, towed array, acoustic intercept sensor, radar, underwater phone and off-board sonobuoy sensors. This effort will develop new technologies to provide the analysts with a consolidated underwater picture of USW sensor data. Technologies that need to be developed include; drill down information/display hierarchy, radar/sonar contract fusion, novel display concepts and color mapping innovations for added operator visualization.

PHASE I: Develop a system design for consolidating acoustic displays and automated processing measurements from the full complement of USW sensors and processing functional segments. Objective of this effort shall be performed without increasing current manpower allocations or watch standers billets. At the same time, this effort needs to provide displays that our operator oriented from a geo-situational contact basis. Phase I shall define the information processing algorithms required associating data from these diverse acoustic sensors and functional segments.

PHASE II: Implement and test a prototype USW data fusion capability as described in Phase I in a laboratory environment. Demonstrate performance with recorded at-sea data from surface ship USW sensors on the prototype lab system. Compute performance metrics for the implemented data fusion and displays

PHASE III: Integrate a USW data fusion capability into the AN/SQQ-89(V) surface ship USW combat system. Install and test the real-time prototype system on a grey boat as directed by PMS 411 for at-sea test.

COMMERCIAL POTENTIAL: This system could be applied in any complex system that requires analyst to merge data from multiple detection or imaging sensors.

KEYWORDS: Automation, acoustic sensors, information processing, real-time, fusion, and sonar

N01-128 TITLE: Novel Approaches for Automated Information Processing of Active Sonar Data

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT II, AN/SQQ-89A(V)15

OBJECTIVE: Investigate and develop new automation techniques for the analysis of active sonar matched filter data to discriminate target returns from clutter.

DESCRIPTION: A crucial problem in active sonar is discrimination of targets from clutter, especially in littoral regions which have many confusable features. The receiver function that facilitates target identification, typically following beamforming and matched filtering, is referred to as Information Processing (IP). Even systems with large transmitter source level, extensive bandwidth, or high gain receive arrays cannot be effective without a reliable IP function. Active information processing in past systems has been primarily focused on parameterized methods measuring features within the matched filter, or threshold crossing data, or tuned neural networks.

New active information processing methods are sought for automation and clue processing of active return data from low speed targets in littoral environments. R&D innovations are specifically needed to deal with the technical uncertainties of bistatic and multi-static systems now in development. There is a need to reduce the technical risks associated with these types of systems due to complex acoustic propagation, bottom interaction, waveform distortion, and loss of signal coherence due to multipath. . As indicated in the references, a significant R&D challenge is false alarm reduction. The littoral environment presents the further complications of convolved noise and non-stationarity, for which optimum processing solutions are not available in the literature. Technical parameters of interest are: operating frequency bands of 50 to 6000 Hz, Doppler processing for target speeds from 0-10 knots, waveform types including continuous wave and swept frequency modulation, sensor types including hull-mounted and towed arrays with up to 400 sensor channels.

Offerors should propose novel information processing approaches which would specifically reduce the technical risks presented by low Doppler target processing in littoral areas. Proposed techniques should be theoretically well founded and show feasibility for robust performance across the range of Navy sonar operating environments, without extensive tuning or reliance on frequent operator adjustment. Proposed algorithms must be capable of running effectively in real-time on modern processors. IP processing techniques for low and middle frequency, and proposed wide bandwidth systems are of interest.

PHASE I: Develop and describe the theory and proposed implementation of the selected information processing algorithms. Demonstrate prototype processing on synthetic data. Develop computational timing and sizing metrics and sonar performance metrics for the implemented algorithms.

PHASE II: Implement the proposed algorithms in a lab environment. Conduct processing on sea data from active systems (to be provided by the Navy). Compute performance metrics for the implemented algorithms.

PHASE III: Implement the successful information processing algorithms for real-time execution in a fielded system. Install and test the real-time prototype system on a Navy-specified platform for at sea testing.

COMMERCIAL POTENTIAL: Commercial acoustic imaging sonar suffer the same requirement to discriminate targets from clutter. The results of this task could vastly improve fish-finding sonar, sub-bottom sediment classifying sonar, bathymetry swath sonar, buried object detection sonar, and harbor survey sonar.

REFERENCES:
1. Stanton, T.K., Acoustic Classification of Irregular Bodies, Woods Hole Oceanographic Inst., 1996, (NTIC AD-B206 613L).
2. Coon, A.C., Survey of Classification Techniques for Impulsively Activated Sonar System with Applications to Extended Echo Ranging (EER) and Improved EER (IEER), Johns Hopkins University, Applied Physics Lab., Aug. 1996, APL90-20595-013 (NTIC AD-C057 339).

KEYWORDS: Active sonar; Signal Processing; Real-Time; Information processing; Algorithms; Underwater Acoustics

N01-129 TITLE: Thermal Stress Management of Infrared (IR) Windows

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: PMS 422 (Standard Missile)

OBJECTIVE: Develop technologies that reduce or eliminate aerodynamic heating of optical windows used in conjunction with passive IR detectors.

DESCRIPTION: The passive IR homing systems used for certain missile systems usually observe the outer environment through a protective window. Since these IR homing systems tend to be at the tip of the missile, the protective windows undergo aerodynamic heating as missile flight velocities increase. The elevated window temperatures can range from 5° to well over 100° C above ambient and introduce noise into the IR sensor, often corrupting its performance. The Navy is seeking technologies to prevent or negate this heating effect. Innovative adaptations of existing technologies or new technical approaches are needed to minimize the influence of the protective window on IR sensor performance. The Navy is seeking to apply this technology to both passive and active sensor/seeker systems for missiles and satellites so volume, weight, reliability and power requirements are a concern.

PHASE I: Develop concepts and design approaches that provide appropriate thermal control to IR windows to meet nominal sensor system requirements. Fully describe the theory of operation of the concept or approach. Provide a detailed description of the technology concepts and/or materials that prevent or negate window heating. Provide analysis showing concept performance characteristics and limitations.

PHASE II: Design, build and test a prototype system based on the technology products of Phase I. Based on the nominal IR sensor used in Phase I, show the ability to render the protective window to a useful, non-disruptive status at velocities of Mach 1, 2, and 3 (1000 ft. altitude, 1976 Standard Atmosphere). Show how the design might perform for alternative window profiles relative to thickness and shape (such as spherical, conical or flat) based on projected steady-state aerodynamic effects.

PHASE III: Depending upon Phase II results, transition to advanced development of a full-up design and production package.

COMMERCIAL POTENTIAL: Passive IR sensors are seeing increased application in commercial transportation. High speed private/corporate jets and space launch/reentry vehicles are a potential market.

REFERENCES:

1. Analytical method to calculate window heating effects on IR seeker performance: (SPIE Proceedings Vol. 2286 Paper # 2286-58)
2. By E.F. Cross (EFC Research Associates, Los Angeles, CA)
3. Infrared Window and Dome Materials (Tutorial Texts in Optical Engineering ; V. Tt 10) by Daniel C. Harris. Paperback (July 1992)
4. Window and Domes Technologies and Materials III (Proceedings of S P I E, Vol 1760) by Paul Klocek(Editor). Paperback (December 1992)

KEYWORDS: IR Window; Seeker; Sensor

N01-130 TITLE: Integrated Underwater Sensing System for Platform Safety & Threat Alertment

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT IV: PEO Mine Undersea Warfare (MUW)

OBJECTIVE: Conceptualize, develop and demonstrate a scaleable and modular integrated underwater sensing system, which can ultimately be adapted for installation aboard ships of any size for protection against navigational hazards, combatant and terrorist threats. The system will be able to automatically detect and warn of natural, man made, and human threats to ships navigation and safety. Explore techniques to detect, identify and provide alertment for hazards to transit operations, amphibious operations, and in-port scenarios. Develop software algorithms to distinguish actual environment from threat features. Investigate the integration of multiple ship functions and develop capability to scan immediate underwater battlespace for threat features, asymmetric threats, natural hazards, obstacle hazards and mine threats. Method of detection and reporting may be based on existing or emerging technologies.

DESCRIPTION: Accurate and reliable underwater sensing, interpretation, and display are critical to Ships safety both underway and in port. These critical measurements must be made with the range of constraints of the open ocean and near shore (littoral) environments. System design must overcome technical challenges such as: 1) environmental effects (temperature and salinity changes, biofouling, turbidity, corrosion), 2) interference from ship's own electronics and sonar, 3) signature detectability and discrimination of natural, man-made, and human entities, 4) calibration, servicing and mounting methods. In addition to these design considerations, the integrated underwater sensing system must also provide a) automatic alerts, b) accuracy and resolution to allow for appropriate and timely ships actions, c) functionality during transit, maneuvering, and dockside operations, and d) scalability for installation on all ships. Because of the existing and evolving need for this capability, the possibility for rapid development and production is desired.

PHASE I: Develop proof of concept designs of the integrated underwater sensing system based on current COTS available technology. Cost would include engineering design of prototype, schedule for prototype production and delivery for testing, and development of a test program to demonstrate critical functional design capabilities. The concept development plan shall include a detailed analysis of logistics functions and costs, and proposals for Total Ownership Cost (TOC) reductions. Total Phase 1 cost is estimated to be $70K.

PHASE II: Develop prototype system and demonstrate proposed functionality against navigational, terrorist, mine, and littoral obstacle threats. Develop well-defined plans for prototype installation onboard a Fleet representative test platform and conduct evaluation testing. Data collection and analysis methods must be identified. Develop a streamlined through-life logistics plan that maximizes effective logistics at minimum cost by innovative structuring of work division between industry and government (best value). Engineering design will address scalability of functions to meet needs of various Military and Commercial Vessels. Cost to procure prototype system including remote readout and control at underway bridge station and inport quarterdeck area is estimated at $700K for system development, installation and logistics planning, and testing. The ultimate target price of a production system is estimated at $175k or less per unit. A testing plan will be developed to test the IUSS's capabilities against four specific scenarios; forward looking navigational hazards and bottom depth sounding/profiling while underway; underwater swimmer detection; small boat approach evaluation while moored pier side and at anchorage. Actual test execution will occur on the NUWC Division Keyport Ranges leveraging from USN Ships assets. Data will be collected using Windows based programs and stored on the hard drive of a lap top computer. Analysis will consist of comparing bottom profiles with know contours in the Puget Sound Basin. Data will be time and GPS synchronized to ensure accuracy of comparison. Static (pierside/anchored) testing analysis will be made against real time "battle problem" detailed in the test plan. Initial detection will be along known lines of bearing progressing to "weapons free" threat introduction from any quarter.

PHASE III: Transition final design data to production of an integrated underwater sensing system that provides depth sounding, underwater threat detection, and hazard avoidance capabilities. Transition capability as a replacement for the AN/UQN-4 Depth-Sounding Fathometer and adapt final design to backfit systems on commercial and military platforms.

COMMERCIAL POTENTIAL: Such a system could be used by commercial Cruise Ship, Ferries,
Freighters, Oil Tankers, and other commercial vessels to assist in safe navigation of restricted waters and warn of potential underwater threats. Other potential applications would aid commercial dredging, cable laying, and bottom survey operations.

REFERENCES:

1. AN/UQN-4 Depth-Sounding Fathometer technical specifications

KEYWORDS: Depth Sounder; sonar; counter-terrorism; mines; obstacle avoidance; swimmer detection

Office of Naval Research (ONR)

N01-131 TITLE: Multiple-Beam Electron Gun for High Power Amplifiers

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: To develop a low voltage multiple-beam electron gun for a high power multiple-beam amplifier (MBA) operating in S-band. MBAs are a device technology with the potential to provide the increased bandwidth, high average power, and low-phase-noise performance required by shipboard radar to keep pace with evolving anti-ship cruise missile (ASCM) and tactical ballistic missile (TBM) threats.

DESCRIPTION: The main focus of the development is multiple-beam generation and transport. Previous work in the FSU has concentrated on low-convergence guns resulting in high cathode-loading (>15 A/cm2) and relatively short operational lifetimes. This development will explore more highly convergent multiple-beam gun designs using the 3-D electron gun code, MICHELLE (ONR-funded), to reduce cathode loading below 10 A/cm2, improving operational life. The magnetic circuit will be designed using a commercial package, such as MAXWELL 3-D. A beam analyzer will be fabricated to validate the gun design and beam transport system.

PHASE 1: Initial design of a multiple-beam gun using 3-D design tools such as the Gun/Collector code MICHELLE (supplied by the government at no cost), and a 3-D magnet code, such as MAXWELL3D.

PHASE II: Design and demonstrate a multiple-beam (no less then seven beamlets) electron gun capable of generating total of 1.5 megawatts of beam power, with a cathode loading consistent with SPY-1 application lifetimes. Demonstrate 98% beam transmission through each individual beamlet channel.

PHASE III: Integrate the electron gun with the other components of the S-band MBA in collaboration with naval researchers.

COMMERCIAL POTENTIAL: Commercial applications of multiple-beam amplifier technology include broadband high power amplifiers for commercial satellite uplinks and high-energy accelerators, where the low operating voltage is attractive due to reduced costs and increased reliability.

REFERENCES:

1. E.A. Gelvich, et al, "The new generation of high-power multiple-beam klystrons," IEEE MTT Transactions,41, 15-19 (1993).
2. L.M. Borisov, et al, "High-power multi-beam vauum microwave amplifiers," Elektron. Tekhnika, Ser. 1, Elektron.SVCh, No. 1, 12-20 (1993) (in Russian).
3. C. Bearzatto, A. Beunas, and G. Faillon, "Long pulse and large bandwidth multibeam klystron," paper presented at the RF-98 Workshop, Pajaro Dunes, CA, October 1998.
4. Y. Besov, "Multiple-beam klystrons," paper presented at the RF-98 Workshop, Parajo Dunes, CA, October 1998.

KEYWORDS: electron gun, multiple beam, multiple beam amplifier

N01-132 TITLE: Low-cost. Lightweight, Mid-Wave InfraRed (MWIR) Sensors

TECHNOLOGY AREAS: Sensors

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT ID: AAAV(Advanced Amphibious Assault Vehicle)

OBJECTIVE: Develop and demonstrate a camera operating with a one-stage thermoelectric cooler capable of fast photoresponse in the 3-5 micron waveband.

DESCRIPTION: Current technology for detection of ordnance, gunfire, rocket plumes and fires involves the use of cryogenically-cooled cameras in the Mid-Wave InfraRed (3-5 microns wavelength) spectral band. These sensors use InfraRed Focal Plane Arrays (IRFPA's) that operate between 70 K to 130 K temperatures, depending on the material and may consist of either single-color or multiple-color approaches. These cooled IRFPA's have been able to make successful technology demonstration sensors; however, they are expensive (of the order of $100,000 / camera) and bulky (typical weights of 5 pounds for a militarized cooled MWIR camera). This makes them unaffordable and impractical for many Marine Corps and Naval applications. Such system applications include self-defense/situational awareness/warning sensors of expeditionary and land-warfare craft such as AAAV, LCAC, and HUMMWV; low-cost, lightweight Unmanned Aerial Vehicles (UAV) sensors; and individual infantryman systems. The goal of this SBIR is to develop technology for cameras which would be an order of magnitude cheaper and lighter than the current generation of MWIR camera. The largest R&D risk factor is the MWIR IRFPA.

PHASE I: Develop a conceptual design of a MWIR IRFPA (detectors and readout) with approximately a 256x256 format, 60Hz (or greater) frame rate, and pixel sizes of approximately 25 - 50 microns (less is preferred). Detectivity D* should be 1E10 Jones or greater at an operating temperature that can be provided by a low-cost, low-power thermoelectric cooler.

PHASE II: Fabricate, test, and deliver a prototype camera using a narrow band (0.1-0.2 micron wide waveband suitable for plume detection) MWIR IRFPA based upon the design in Phase I. Because the emphasis will be on IRFPA development, camera Field of View is flexible - it should be somewhere from 30 to 95 deg x 30 to 95 deg. Assess applicability and extension of the technology to multispectral IRFPA's.

PHASE III: Demonstrate low-cost producibility and develop an implementation plan for large scale production of cameras (under $10,000 / unit goal for > 300 cameras/year production). Demonstrate successful lightweight (under 1 lb.) cameras and/or multispectral versions of the MWIR IRFPA cameras for military and commercial applications.

COMMERCIAL POTENTIAL: The manned land/sea/air vehicle, UAV, and infantry military market for such sensors could be in excess of 1000 cameras per year. Additional applications such as spectroscopy, remote sensing, medical imaging, firefighting, police/border patrol, and other government/commercial/scientific applications could have a market of tens of thousands/year. As camera costs drop, the market for such devices is likely to expand rapidly.

REFERENCES:

1. S. Jost et al, "Room Temperature MWIR FPA's - Return of the Lead Salts?", Proceedings of the 1999 MSS/IRIS Conference on Infrared Detectors, published by Veridian/ERIM International, 1999

KEYWORDS: Infrared cameras, electronic warfare, detectors, detection

N01-133 TITLE: Maritime Intelligence, Surveillance, Reconnaissance (ISR) and Space Exploitation

TECHNOLOGY AREAS: Battlespace, Space Platforms

OBJECTIVE: Further the development of technology to automatically develop complete awareness of the littoral maritime situation long before, leading up to, during, and after military engagement.

DESCRIPTION: The focus of this SBIR topic is to stimulate bold new concepts for significantly increasing the performance of automated maritime ISR including use of space assets. The Century 21 Navy will need complete awareness of the sub-surface, and surface situation within a wide area of interest. This SBIR focuses on the littoral situation, which is complicated by the presence of many neutral surface ships of all sizes and purposes as well as friendly and enemy combatants, including mines. Awareness must extend seamlessly across time, beginning well before and extending through hostilities. Situation Awareness must be consistent among all involved. Situation Awareness will be expressed in the form of a complete picture of who is where as a function of time. This picture will be available to all Naval personnel at an appropriate level of resolution. This SBIR focuses on aspects of maritime ISR other then conventional ASW and MCM since these are covered by other SBIR topics. Novel means of exploiting existing sensors, including space sensors are of interest. Methods of detecting and classifying (or, in some cases, identifying) neutrals (commercial shipping, fishing and pleasure craft) and unusual threats such as small surface craft (i.e. “Boghammers”) and small submarines (diesels or mini-submarines) are of interest. Examples include but are not limited to: 1) surface ship surveillance exploiting ship acoustic, electromagnetic, or hydrodynamic signatures or use of GPS signals or low resolution space based radar to illuminate the ocean surface; 2) undersea surveillance via fusing of passive acoustic and non-acoustic sensing. Methods of tracking entities of interest in the complex littoral environment are sought. The littoral scene may contain many objects with crossing paths and unknown motion models. Methods of maintaining a consistent awareness of the situation among Navy personnel who are dispersed and intermittently in contact with each other are sought.

PHASE I: Develop a complete algorithm or detailed description of the proposed ISR concept. If the concept involves hardware produce a design. This algorithm, description, or design and supporting documentation should be sufficient to convince qualified engineers that the proposed concept is technically feasible.

PHASE II: Produce and demonstrate performance of a computer program based on the algorithm or description of the concept. If the concept involves hardware, produce and demonstrate performance of an eXploratory Development Model (XDM). Demonstrate performance in such a way as to convince qualified engineers that the proposed concept is capable of meeting requirements in an operational environment.

PHASE III: Team with the manufacturer of one of the Navy's ASW or MIW ISR systems to integrate the concept into future generations. Team with manufacturers of commercial fusion systems, such as air traffic or harbor control, to integrate the concept into these products.

COMMERCIAL POTENTIAL: There is a commercial market for ISR concepts applied to air traffic and harbor control. There is a growing commercial market in tracking littoral traffic for law enforcement (smuggling and illegal fishing).

REFERENCES:

1. Waltz, Edward and James Llinas, "Multisensor Data Fusion," Artech House, 1990, Bar-Shalom, Y., "Tracking Methods in a Multitarget Environment," IEEE Transactions on Automated Control, Vol. AC-R3, August 1978, pp. 618-626

KEYWORDS: Electromagnetic, Acoustic and Hydrodynamic signatures, multitarget tracking, state estimation, common tactical picture

N01-134 TITLE: <u>Component Level, Multimedia communication technology for survivability</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Electronics, Battlespace

OBJECTIVE: Develop and demonstrate a dual mode, device level, media communication capability for twisted pair and RF wireless communication, based on the ANSI/EIA 709.x Protocol (commonly known as Lontalk). This technology will enable devices on a twisted pair, distributed control network that have been isolated from the network, due to damage, to reestablish communication via RF transmission.

DESCRIPTION: The Navy has developed an affordable survivable component level intelligent distributed control system architecture for shipboard automation. This architecture employs the ANSI/EIA 709.x Protocol in a dependable topology with embedded online reconfigurability to monitor and detect damage to the twisted pair network and heal network fragments. The dependable topology consists of a partial mesh of rings. Routers interconnect the rings. The component level networks feed into ship-wide area networks. The component level networks consist of intelligent devices that may require communication across the network to perform at full capability (normal operations, casualty control, and damage control). Since twisted pair communication speed and bandwidth exceeds RF speed and bandwidth it is expected that the primary communication medium for these shipboard control networks will be twisted pair. With the Navy's unique requirements for survivability these systems need to be designed for the potential destruction or interruption of the control networks. Therefore, RF wireless communication will be required, as a backup medium, to maintain critical functionality between the devices in the system. The backup device must either be part of the device or co-located with the device. The backup RF connection must allow network communications with the device to dynamically switch from one media type to the other, dynamically reestablishing its identity, functionality, and logical network variable connections on the network. Failures to the twisted pair should be readily isolated from the RF connection.

PHASE I: Perform a tradeoff study that compares wireless bandwidth capacity and cost, and recommend an approach for an affordable backup wireless communications capability. Consider embedded and co-locatable approaches. Proceed to develop a preliminary design of the recommended dual mode (RF-twisted pair) media interface for ANSI-709.1 networks and demonstrate its conceptual feasibility.

PHASE II: Develop the Detailed Design of the dual mode (RF- twisted pair) media interface and demonstrate the RF backup functionality in a live network through the loss of its twisted pair communication interface.

PHASE III: Initiate Low Rate Production of the dual mode (RF-twisted pair) media interface and potential joint development projects with the U.S. Navy Surface Warfare Systems Group

COMMERCIAL POTENTIAL: Multimedia controllers will have great potential in commercial automation systems where continuous availability is important such as production, fire or security system

REFERENCES:

1. Adept Systems Inc. "Self Healing Component Level Intelligent Distributed Control Networks for controllers will have great potential in commercial automation systems Survivable Shipboard Automation Infrastructure" 15 September 2000
2. Analysis and Technology, an Anteon Company "Network Fragment Healing Demonstration Test Procedures" 13 July 2000

KEYWORDS: Component Level, Dual Communication Media, Survivability

N01-135 TITLE: Boost-Phase Sub-Unit Vaccine Development for Binary Vaccines Against Infectious Diseases and Biological Warfare Agents

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: This topic requests the development of a vaccine platform using a recombinant virus and/or viral-like particle to express foreign antigens. The viral platform must be immunogenic but safe for use in humans.

DESCRIPTION: Current human vaccines use multiple doses of the same vaccine to immunize against toxins or pathogens. These vaccines work primarily by inducing neutralizing antibodies, but are not very effective at stimulating T cells to kill invading micro-organisms. Though successful in preventing many human diseases, such unitary vaccines have failed to protect against HIV, TB, and Malaria, which have been designated by the National Security Agency and the President as threatening our national security. They have also proven inefficient in providing immunity to many potential biological warfare agents. Anthrax, requiring a complicated and lengthy immunization schedule, is one such example. Recent animal vaccine literature demonstrates that a two stage vaccine, in which the first dose consists of DNA vaccine and the second dose uses a recombinant, attenuated virus, provides a potent immune responses. However, such immunization strategies using virus or virus-like particles in the boost phase have not been tested in humans because of concerns about safety. The research component of this Topic would consist of selecting and engineering one of many possible viral systems to have the dual characteristics of safety and high immunogenicity. Successful preclinical development of such a viral vaccine would lead to a platform technology for development of vaccines for a large number of emerging disease or biological warfare threats.

PHASE I: Develop a prototype viral based vaccine platform predicted to have the required safety and immunogenicity characteristics. As a proof of principle, insert selected proteins from malarias pathogenic to animals into the platform virus. Produce enough of these constructs under research grade conditions to test in-vitro expression of malaria proteins and immunogenicity and protection against malaria infection in mice and monkeys. This viral construct will be tested alone and in conjunction with existing DNA vaccines expressing the same malaria antigens.

PHASE II: Produce a viral vaccine expressing antigens from the human malaria P. falciparum under GMP-like conditions. These constructs would form the basis of a viral vaccine against malaria for use in humans. Sufficient vaccine will be produced to demonstrate in-vitro expression of proteins and for testing of immunogenicity in animals. This viral construct will be tested alone and in conjunction with existing DNA vaccines expressing the same malaria antigens.

PHASE III: Demonstrate the ability to manufacture the viral falciparum malaria vaccines under GMP conditions. This product and supporting data should be of high enough quality so that it would meet standards for submission to the FDA for human testing.

COMMERCIAL POTENTIAL: A successful viral vaccine incorporating the attributes desired in this Topic would have profound commercial applications. The viral platform could be used to develop vaccines against many pathogens for which adequate vaccines do not exist.

REFERENCES:

1. Sedegah M, Jones T, Kaur M, Hedstrom R, Hobart P, Tine J, and Hoffman SL. 1998. “Boosting with recombinant vaccinia increases immunogenicity and protective efficacy of malaria DNA vaccine”. Proc. Natl. Acad. Sci USA, vol95, pp7648-7653.

KEYWORDS: Vaccines; Immunology; Heterologous; Prime-Boost; Infectious Diseases, DNA.

N01-136 TITLE: Digital Cellular-Phone Transceiver-based Foliage Penetration Interferometric SAR for EO/IR Sensor Fusion ATR

TECHNOLOGY AREAS: Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: NAVSEA PMS-529

OBJECTIVE: Develop inexpensive digital cellular-phone transceiver-based foliage penetration interferometric SAR to be fused with IR hyperspectral imagery for terrain map navigation and for automatic target recognition (ATR) suitable for UAV operation.

DESCRIPTION: In principal dual frequency interferometric SAR can provide terrain elevation capability for correlation with digital maps for terrain navigation. It should be compatible with low cost digital cellular-phone transceivers with arbitrary waveform generation to transmit message/image data. It is anticipated that the early digitization at the transceiver array will provide at least 100 dB high dynamic range for foliage penetration, 3D imagery, and communication applications. Furthermore, digital FOPEN interferometric SAR 3D terrain imagery can be combined with IR hyperspectral imagery to provide detailed target characteristics needed for ATR.

PHASE I: Provide system and component design of all digital FOPEN interferometric SAR at UHF & VHF dual frequencies in order to meet the requirements of a low-cost device capable of UAV targeting and navigation.

PHASE II: Develop and demonstrate a working prototype digital FOPEN interferometric SAR system.

PHASE III: Applications of digital FOPEN interferometric SAR should include NAVSEA gun-launched UAV.

COMMERCIAL POTENTIAL:
Law enforcement agency requires a high dynamic range and inexpensive FOPEN radar for ground surveillance. This SBIR will have transition to commercial sale to police, drug enforcement agency, NASA resource management, and forest fire fighting.

REFERENCES:
1. “Radar 2000” IEEE Conference Proceedings, Szu et al. “Commercial Application of Digital Radar”, May Washington DC.
2. Digital Array Radar Volume Search Radar, ONR Code 313 Web page

N01-137 TITLE: Expeditionary Logistics

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Use logistics modeling and simulation to establish a qualitative and quantitative disciplined approach to weighing technology focus areas against the larger Naval expeditionary logistics mission. Rapidly define the greatest return on investment for needed capability or requirement in the overall acquisition investment strategy.

DESCRIPTION: Setting requirements and acquisition priorities within the Naval logistics community is a challenge. The systems engineering aspect of Naval operational logistics, and the benefit of a logistics simulation in this area, has proven a complex and challenging problem. The wide variety of variables which must be considered complicates the problem set-up and problem solving environments. Today's tools are varied. There are engineering level models that successfully model characteristics of a piece of equipment and its performance, but these tools do not model the equipment against its purpose. Today's system design evaluation models include many pieces of equipment and govern their interaction, but as the system grows larger (such as Naval logistics) the model either becomes too complex to be employed effectively by the discreet program offices or provides poor resolution in the solution set. A final model type, the battle outcome model, takes into account equipment, troops and doctrine, with simulated interaction between competing forces and survivability of troops and equipment. While this is a useful operational environment, the assessment method of battle outcome wargaming does not take into account the robust variable set that the acquisition community must consider when constructing the analysis of alternatives. Within this proposed development, the end capability should be a tool to help the Naval community understand in context the implications of logistics on new tactics, techniques and procedures. But additionally the tool will assist technologists and acquisition professionals focus resources on the critical drivers (both operationally and at the equipment characteristic level) in supporting the Naval logistics mission profile demands effectively and efficiently.

PHASE I: Modeling parameters, metrics and architecture will be defined. Key technology enablers will be explored and addressed in risk reduction fashion. A balanced matrix allowing dissimilar systems and the dissimilar metrics of operations vice acquisition to be compared will be addressed.

PHASE II: Conduct Model Development. Proposal will address verification and validation plans, data sources, and incremental measures of success/progress that afford the government opportunity for earned value management.

PHASE III: There will be numerous opportunities for follow-on R&D through continuous programmatic coordination with the requirements, doctrine and acquisition communities which will benefit from this tool suite.

COMMERCIAL POTENTIAL: Each of the areas of combat service support are represented in the private sector. Such technological advances in smart buying tools, information management and decision support have substantial marketability.

KEYWORDS: Naval Logistics, Acquisition, Doctrine, Modeling, Metrics

N01-138 TITLE: <u>A Self-Contained Solar Radiation Measurement Package for an Aircraft</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Develop a stand-alone instrument package for measurement of spectrally resolved up- and down-welling solar fluxes and optical depth from an airplane or other moving platforms.

DESCRIPTION: Solar flux measurements from an aircraft require corrections that account for platform attitude and orientation, among other things, and therefore require synchronization and assimilation of data measured by other independent systems. In this development, all sensors needed to provide spectrally resolved fluxes and optical depths should be integrated into one stand-alone system. For example, the radiation sensors might be mounted along with an attitude sensor on a feedback-controlled platform, such that sensor's orientation is actively maintained independently of the aircraft's orientation. Similarly, the optical depth system, whether it is a sun photometer or a shadow-band radiometer should be self sufficient and independent of auxiliary payload measurements. Consideration should be given to miniaturizing the sensors. The primary aircraft is a Twin Otter, but the package should be transferable onto other aircraft. Power for the instrumentation will be provided from the aircraft's 28V DC generators, and data from the instrumentation should be passed to the aircraft's data system. Consideration should be given to minimizing both size and power requirements.

PHASE I: Design a prototype system that can independently do solar radiation measurements from a research aircraft.

PHASE II: Develop and demonstrate a fully capable radiation instrument for use on a research aircraft. Develop commercialization (Phase III) plans, including descriptions of specific applications, potential customers, proposed demonstrations, and transition efforts to be performed.

PHASE III: Replace or modify prototype for a specific application or product.

COMMERCIAL POTENTIAL: Benefits to researchers and to research or monitoring programs are inherent in the objective of the proposed effort. Existing systems rely on data from other measurement systems and large effort in synchronizing and assimilating unrelated measurements to arrive at accurate radiation data. This stand-alone package will provide engineering data in real time, and grossly reduce both time and manpower requirements. The package will benefit ship and aircraft based research, and also, in a simpler version (without orientation feedback controls), land based programs.

REFERENCES:
1. Livingston, J. et al., Shipborne sun-photometer measurements of aerosol optical depth spectra and columnar water vapor during ACE-2, and comparison with selected land, ship, aircraft, and satellite measurements, Tellus (2000), 52B, 594-619. (See also references therein).
2. Formenti, P. et al., Measurements of aerosol optical depth above 3570m asl in the North Atlantic free troposphere: Results from ACE-2. Tellus (2000), 52B, 678-693.

KEYWORDS: Real-time Data Collection; Data Management; and Instrument

N01-139 TITLE: <u>Smart Low Altitude Platform for Atmospheric Measurements from a Research Aircraft</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Develop a capability to tow a smart instrument package bellow a research aircraft and have it stabilize at a specified altitude. The smart package should be able to ``fly'' while towed at a fixed height above the sea surface.

DESCRIPTION: The ability to tow a stabilized smart instrument package bellow a research aircraft opens up a number of possibilities to answer fundamental operational and research questions about the surface flow over the ocean. The smart package should be able to ``fly'' while towed at a fixed height above the sea surface. The operational area of interest for the smart instrument package is the region below 30 meters, which is characterized by high atmospheric gradients. The lowest altitude research aircraft currently operate is usually no lower than 200 meters. There should be space in the smart tow package for instrumentation to include air temperature, humidity, turbulence, and aerosol sensors. Power for instrumentation and smart tow vehicle systems should be provided from the mother aircraft. Data processing and storage for the instrumentation and smart tow vehicle automated flight control systems should also be provided from the mother aircraft. The smart tow vehicle system should be able to be The package should be designed so if it hit the ocean it would not damage the mother aircraft. The system solicited here should be compatible or scalable with a verity of aircraft sizes and types, but operation from small twin-engine aircraft is required.

PHASE I: Design a prototype system that can support low altitude (20-meter) atmospheric measurements from a research aircraft.

PHASE II: Develop and demonstrate a fully capable smart tow vehicle system for use with a research aircraft. Develop commercialization (Phase III) plans, including descriptions of specific applications, potential customers, proposed demonstrations, and transition efforts to be performed.

PHASE III: Replace or modify prototype for a specific application or product.

COMMERCIAL POTENTIAL: Benefits to researchers and to research monitoring programs are inherent in the objective of the proposed effort. Commercial applications include oil spill assessment and mineralogical assessment.

REFERENCES:
1. Edson, JB and CW Fairall 1998: Similarity relationships in the marine atmospheric surface layer. J. Atmos. Sciences, vol 55, 2311-2328.

KEYWORDS: Marian Atmospheric Boundary Layer, Surface ducting, optical propagation, atmospheric measurements, and aircraft towed instrument platform.

N01-140 TITLE: Conductive Carbon Nanotubes for EMI Shielding of Naval Aviation Optical Materials

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: NAVAIR 4.1.8 Survivability

OBJECTIVE: Explore the feasibility of incorporating highly conductive carbon nanotubes in optical materials for Electromagnetic Interference (EMI) shielding. Optical materials such as aircraft canopies and infrared (IR) transparent windows have challenging combinations of electrical and optical requirements to meet Naval Aviation needs. Low loading of conductive fillers is required to have minimal impact to optical transmission through these materials.

DESCRIPTION: Recent advances in the fabrication of conductive carbon nanotube materials has imparted an opportunity to explore nano-molecular particles for EMI shielding for military as well as commercial applications. These materials have demonstrated good electrical conductivity in gap filler materials at low (3-5%) loading levels (Phase I SBIR with Foster-Miller). Furthermore, single walled carbon nanotubes have been demonstrated to increase the strength of polymers by forming strong chemical bonds to the matrix. Demonstrating good electrical conductivity with minimal visual transmission loss through aircraft canopy materials (e.g. polycarbonate) and IR transparent windows (e.g. sapphire, ZnS) would be innovative and provide a technology need for military weapon systems. The conductivity levels measured from a four point probe are of a threshold of 10 ohms per square and an objective of less than 1 ohm per square.

PHASE I: Establish the feasibility of incorporating conductive carbon nanotubes into aircraft canopy materials and IR transmitting materials. Measure optical transmission loss, mechanical strength impact, electrical conductivity, and any marine environmental exposure material degradation due to nanotube incorporation.

PHASE II: Identify EMI shielding optical requirements for specific subsystems components (canopies and IR missile domes) for Tactical Aircraft, Targeting Forward Looking IR (TFLIR), and IR Missile Domes. Fabricate coupons and subsystem components for test and evaluation of EMI effectiveness for aircraft canopies and IR windows.

PHASE III: Initiate production efforts to build and fabricate EMI shielding materials in commercial quantities. Prepare technology transition packages to specific Naval Aviation Program Offices (PMAs) for platform integration, production, and supportability. Prepare design documentation to produce suitable EMI shielding materials for these applications.

COMMERCIAL POTENTIAL: Application in several areas requiring EMI shielding such as commercial aircraft, ground stations, and cellular phones.

KEYWORDS: EMI shielding, optical materials, carbon nanotubes

N01-141 TITLE: Portable Emissivity / Reflectometer for Measurements on Curved Surfaces

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: NAVAIR 4.1.8

OBJECTIVE: Develop a hand held emissivity measurement tool device to verify and quantify the infrared properties of installed materials such as paints and coatings on curved surfaces. The lightweight portable device should work on exterior surfaces with radii of 3 inches or greater and internal surfaces with radii of 12 inches or greater.

DESCRIPTION: Recent advances in Bi-directional Reflectometry (BRDF)measurement technology have shown the feasibility of conducting field emissivity measurements of flat surfaces coated with materials for enhanced reflective or emissive properties for improved durability performance. However, these hand held measurement tools require flat surfaces and are also difficult to handle due to high temperatures generated by the device during calibration. Many critical installations are made on singly and doubly curved surfaces and cannot be measured with this technology. This activity would conduct innovative research into the feasibility of accomplishing portable, lightweight, accurate, and calibrated BRDF measurements in the field without current constraints for nearly flat surfaces.

PHASE I: Conduct research into eliminating current limitations on curvature for conducting infrared measurements. Investigate alternative sensors and concepts to meet interior and exterior measurement needs with a single device. Establish the requirements for measurements in the naval environment.

PHASE II: Assess the needs for verification of infrared performance of the outer mould-line and engine cavities. Develop laboratory model of device using representative surface curvatures and coatings and design/build a prototype measurement device. Conduct field demonstration of prototype to verify its performance. Develop cost information and design specifications for a production measurement device.

PHASE III: Initiate production efforts to build the measurement device in commercial quantities. Prepare transition packages for specific platform organizational and depot support units.

COMMERCIAL POTENTIAL: A portable device for the measurement of infrared properties would have application in a commercial area such as industrial furnace maintenance and manufacturing where the durability of high temperature coatings is monitored. Monitoring is critical for process control such as uniformity of temperature.

KEYWORDS: Measurement, infrared, emissivity, reflectance

N01-142 TITLE: Rapid RF Switching Conducting Polymers

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: NAVAIR 4.1.8 Survivability

OBJECTIVE: Explore the feasibility of developing rapid switching conducting polymers from low dielectric (opaque/RF transmissive) to high dielectric (conducting/RF reflective) materials for Electromagnetic Interference (EMI) shielding. Innovative rapid RF shuttering technology is need for multiple Naval Aviation antenna applications for EMI shielding.

DESCRIPTION: Recent advances in the fabrication of low cost conducting polymer materials has imparted an opportunity to explore these materials for EMI shielding of military antenna systems. Advance material research in conducting polymers is needed to provide affordable supportable solutions for RF shuttering to meet low one way transmission loss (<0.5 dB) from 2-18 GHz, rapid (<0.1 seconds) switch from conductive to opaque state, complex shape integration (flat to doubly curved surfaces), multiple cycle reliability (>10,000 cycles), low cost, and maintainability in a marine environment.

PHASE I: Establish the feasibility of incorporating conducting polymer switches for EMI shielding of antennas. Measure one-way RF transmission loss, mechanical strength, electrical conductivity, and any marine environmental exposure material degradation.

PHASE II: Establish EMI shielding optical requirements for specific subsystems components (antennas) for Tactical Aircraft, Rotary-Wing Aircraft, and weapon systems Fabricate coupons and subsystem components for evaluation.

PHASE III: Initiate production efforts to build and fabricate EMI shielding materials in commercial quantities. Prepare technology transition packages to specific Naval Aviation Program Offices (PMAs) for platform integration, production, and supportability. Prepare design documentation to produce suitable EMI shielding materials for these applications.

COMMERCIAL POTENTIAL: Application in several areas requiring EMI shielding such as commercial aircraft, anti-static carpets, computers, and cellular phones.

KEYWORDS: EMI shielding, RF shuttering, conducting polymers

N01-143 TITLE: Compact, Digital Man-Portable Infrared (IR) Measurement Device

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: NAVAIR 4.1.8 Survivability

OBJECTIVE: Investigate the utility of and develop a hand-held IR measurement device to be used in an operational field/fleet environment to evaluate the IR signature characteristics of U. S. Naval aircraft and other military vehicles. The lightweight portable device should be usable and effective in adverse field conditions and simple to operate. Device should include software capability to compare reference datum and extract changes with sensitivities to less than 3 degrees F relative temperature, and changes in emissivity of less than 10 percent from reference datum at selective bands within the midwave infrared wavelengths and longwave wavelengths.

DESCRIPTION: As the U. S. Navy continues to design, develop and field advance coating technologies on military aircraft and UAVs, it is absolutely critical to the operational forces to ensure that the IR signature characteristics of the vehicle are not degraded in the harsh operational environments of aircraft carriers, ships in rough seas, and combat operations. As these systems are fielded, provisions are being made to evaluate and accurately measure their signatures in controlled environments with specific IR signature measuring equipment that will fully characterize the IR signature of the vehicle. These controlled measurements can only be conducted at depot or manufacturing plants where proper equipment and facilities are available.

This SBIR focuses on development of a small (less than one cubic foot volume for logistics footprint), lightweight (less than 8 pounds threshold and less than 5 pounds objective), digital IR camera that can be packaged as a man-portable measurement device to evaluate specific areas of a vehicle, to ensure that materials or durability coatings have not been degraded or damaged during operational use. The device will image the vehicle and provide a real-time IR image of the vehicle and associated scene background. The IR sensor must be capable of evaluating emissivity and/or thermal measurements and employ a suitable method of calibration and background/scene comparison to determine aircraft “hotspots” that are indicative of changes to the material properties on the vehicle surface, due to damage or materials degradation.

PHASE I: Conduct a feasibility study and requirements analysis that will result in the successful design and integration of various sensors/components needed to build a light-weight, digital, man-portable IR camera, with application as an evaluation tool for IR signature measurements and vehicle materials characteristics in an operational field environment. Define the range of operational performance and concept of operations for the device. Investigate alternative commercial off- the-shelf (COTS) sensors and concepts to meet measurement and evaluation needs with a single device. Establish the requirements for measurements in the naval environment.

PHASE II: Develop and build a working prototype of the IR measurement device. Demonstrate the ability of the device to identify “hot spots” on the vehicle and associated defects or material degradation that may have occurred. Assess the needs for verification of IR performance or calibration, based on baseline signature. Conduct a field demonstration of the prototype to verify measurement performance. Deliver a system specification to produce this device in Phase III. Develop cost information and design drawings suitable for device production.

PHASE III: Design and produce this digital IR measurement device in production quantities. Complete all support documentation for the device, including user’s manual, maintenance/repair manuals, and an operations/evaluation guide

COMMERCIAL POTENTIAL: A portable device for the measurement of IR properties would have wide application in many commercial areas, such as police IR sensors, laboratory and industrial maintenance and manufacturing applications, where the durability of high temperature or durability coatings needs to be monitored and evaluated.

KEYWORDS: Measurement, infrared camera, emissivity

N01-144 TITLE: Small Diesel Engines, JP5 / JP8 Fueled

TECHNOLOGY AREAS: Air Platform, Electronics

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMR-51

DESCRIPTION: Small model aircraft diesel engines are now commercially available as units and conversion components. These engines are designed to run on model aircraft diesel fuel, which is modified with high volatility ether for ease of starting. For use on Navy ships, small diesel engines would be required to operate on standard Navy heavy fuels, such as JP5 (MIL-DTL-5624) and JP8 (MIL-T-83133), with no volatile additives allowed. Development of highly efficient, small diesel engines (suitable for small UAVs) are needed to satisfy the standard Navy heavy fuel requirement. There are no engines currently available to meet this requirement

PHASE I: Demonstrate 24-hour operation using both JP5 and JP8 fuel (with no volatile additives) on a COTS, modified COTS, or prototype engine with 0.25 cubic inch displacement (cid). Demonstrate a specific fuel consumption (SFC) of less than 1.2 lbs/hp-hr (at sea level) while producing at least 1.4 hp/cid @ 11,000 rpm (at sea level) while maintaining a total engine weight (excluding propeller) of less than 10 oz and an estimated cost of less than $100 each in 100 lot quantities. Demonstrate a cold starting system that is portable, reliable, and inexpensive to produce. Estimate cost of production for 100 lot and 1000 lot purchases. Provide five samples of the prototype engine system.

PHASE II: Continue development of the 0.25 cid engine to demonstrate an SFC of less than 0.8 lbs/hp-hr (at sea level) and specific output of >1.8 hp/cid @ 11,000 rpm (at sea level) while increasing uninterrupted endurance to 48 hrs using both JP5 and JP8 fuels. Extend the design to an engine of approximately 2.0 cid with similar performance @ <6,000 rpm. Estimate cost of production for 100 lot and 1000 purchases for each size engine. Provide five samples of each size prototype engine system.

PHASE III: Prepare fabrication drawings and specifications of final designs for both size engines. Provide statistically valid performance and operational data including data for SFC, specific output, and uninterrupted endurance. Demonstrate engines in generic aircraft in various operational conditions, specifically winter operations. Refine cost estimates for 100 lot purchases. Provide twenty samples of each size engine system.

COMMERCIAL POTENTIAL: Small, efficient, diesel engines designed to operate on standard, turbine engine aviation fuels will have narrow application.

KEYWORDS: internal combustion; diesel; fuel; Specific Fuel Consumption (SFC); engine starting; JP5 / JP8

N01-145 TITLE: Very Low Cost, Lightweight Detector Technologies for Small, Expendable Unmanned Air Vehicles (UAVs)

TECHNOLOGY AREAS: Chemical/Bio Defense

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMR-51

DESCRIPTION: A potential role for very low cost UAVs would be to provide either perimeter detection and alert or over-the-horizon intelligence to forces afloat, particularly during operations other than war. The detectors needed are primarily for the following classes (not necessarily simultaneously):

a) biological / chemical agents
b) nuclear radiation
c) explosives

Therefore, the U.S. Navy has a need for sensors capable of detecting, identifying, and then quantifying toxic, airborne chemical or biological agents, nuclear radiation, or explosives. These sensors should be compatible with deployment on small, expendable UAVs. Therefore, the sensor system should be lightweight (<4 pounds), small (<200 cubic inches), rugged, have low power consumption (<6 WDC), very low cost (<$1,000 each), and capable of autonomous operation. The sensor should be capable of simultaneously detecting several (>10) toxic agents at very low concentration (or level, as appropriate) with a low false alarm rate. The sensor system should be capable of assaying an air sample in near real-time (<60 seconds). The sensors should be capable of performing this near real time monitoring for a minimum period of 24 hours in a marine environment.

PHASE I: Examine potential sensor technologies for one or more of the above classes of threats. Evaluate two different technologies for applicability and build a lightweight breadboard prototype for demonstration. Measure the response levels and times for these sensor technologies using simulants or sources as appropriate. Assess potential costs for volume (1000 lot) production. Provide sample sensor system for government evaluation

PHASE II: Refine the technologies providing the best estimated combination of cost, weight and performance and demonstrate brassboard construction and delivery of 3 functional units for test and evaluation. Measure the response levels and times for these sensor technologies using real agents or sources as appropriate. Estimate final production costs for 1000 lot production.

PHASE III: Complete brassboard design and demonstrate production capability with the construction and delivery of 25 functional units from prototype construction. Measure the response levels and times using this sensor system in a UAV using real agents or sources as appropriate. Refine final production costs for 1000 lot production.

COMMERCIAL POTENTIAL: The demonstration of very low cost sensor technology will enhance the capability to incorporate a vast array of new sensors into both consumer and industrial goods.

KEYWORDS: sensor, chemical, biological, explosive detector, electronic nose, UAV, very low cost

N01-146 TITLE: Airframe Construction for Small, Expendable Unmanned Air Vehicles (UAVs)

TECHNOLOGY AREAS: Air Platform, Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMR-51

DESCRIPTION: Most current UAVs are manufactured in a manner similar to prototype aircraft. While these techniques result in vehicles that are dimensionally accurate and aerodynamically capable, the costs are substantial. If an expendable UAV is to be adopted for general use, its construction cost needs to be low. Therefore, a significant emphasis must be placed on the fabrication of the airframe using inherently low cost processes, while maintaining the required aerodynamic and dimensional tolerances. There are a number of novel polymer fabrication technologies that may provide suitable performance but have never been evaluated for this large a component or have never been developed to maintain the exacting dimensional characteristics that would be required for an aerodynamic application (3D accuracy and surface finish).

PHASE I: Examine potential non-metallic fabrication technologies. Fabricate 4’ prototypes using three to four of the suggested technologies and assess their performance, both structurally (static and dynamic) and aerodynamically as a function of weight. Goals for this phase would be a hardbody (wing, fuselage) and control surfaces weighing less than 2.6 lbs while capable of withstanding 10g acceleration (5 seconds) due to downdrafts for a completed vehicle weight of 20 lbs. Furthermore, the exterior dimensional goals should be 0.050” (in all three axes) and a surface finish and waviness of less than 8 microinches rms. Statistically measure and document the progress toward meeting these goals. Age six complete samples at elevated temperature (140F) for 24 hours, remeasure dimensional tolerances and report.

PHASE II: Select the two technologies assessed to provide the best combination of cost and performance and demonstrate low volume production (using prototype tooling and quality control) of selected airframes with the construction and delivery of 10 units using each technology. Goals for this phase would be a hardbody (wing, fuselage) and control surfaces weighing less than 2.0 lbs while capable of withstanding 10g acceleration (5 seconds) due to downdrafts for a completed vehicle weight of 20 lbs. Furthermore, the exterior dimensional goals should be 0.025” (in all three axes) and a surface finish and waviness of less than 8 microinches rms. Statistically measure and document the progress toward meeting these goals. Age six complete samples at elevated temperature (140F) for 48 hours, remeasure dimensional tolerances and report.

PHASE III: Select the final technology providing the best combination of cost and performance and demonstrate volume production (using production tooling and quality control) of selected airframes with the construction and delivery of 40 units. Statistically measure and document the final weight and dimensionally accuracy of the delivered units. Age six complete samples at elevated temperature (140F) for 96 hours, remeasure dimensional tolerances and report.

COMMERCIAL POTENTIAL: The demonstration of very low cost, highly accurate non-metallic fabrication technology will permit designers to conceptualize a vast variety of large, low cost precision items for both the consumer and industrial markets.

KEYWORDS: precision manufacturing, UAV, low cost, non-metallic, fabrication, small airframe

N01-147 TITLE: Very Low Cost Unmanned Air Vehicle (UAV) Avionics

TECHNOLOGY AREAS: Air Platform, Electronics

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMR-51

DESCRIPTION: For a well-developed small Expendable UAV, the predicted cost of the airframe and power plant are very low – in the order of several hundreds of dollars. The cost drivers for these systems are both the communications and avionics subsystems. This effort addresses the avionics portion where costing progress must be made. A very low cost, lightweight (~6 oz), low power (<3 WDC), high-update rate avionics module is needed for supporting airframes ranging from 2 to 12 foot wingspan. This module should provide real-time GPS, independent inertial guidance, the storage of hundreds of geographic waypoints, the adaptive capacity to cross waypoints at designated times, and allow the input from off-board sensors to be used to alter its flight plan. It must operate in a high EMI environment, use minimal power, and remain reliable for >100 hours while operating in a very high vibration environment.

PHASE I: Design a breadboard avionics system (including all servos) that will be inexpensive to produce and demonstrate system performance using generic control laws. The cost target should be approximately $400, or about 30% of commercial systems that are currently available. Preliminary packaging concepts are to be explored and he sensitivity of the system to extremely broadband EMI is to be measured. The operation of the system under realistic GPS spoofing situations is to be evaluated and the ability to switch to inertial guidance will be demonstrated. A complete prototype of the avionics system is to be provided to the government for test and evaluation.

PHASE II: Demonstrate potential producibility and operation of prototype system. Verify performance and reliability of brassboard systems in prototype air vehicles in a high EMI environments and under simulated GPS spoofing conditions. Demonstrate operation in a wide array of temperature/humidity environments in the laboratory. Provide 5 complete avionics systems for government test and evaluation

PHASE III: Complete designs suitable for high-rate fabrication. Develop production and test systems to statistically ensure reliable operation of 99% of delivered units. Provide 10 complete avionics systems for test and evaluation.

COMMERCIAL POTENTIAL: The cost target of this system will put it into a cost area that is viable for model airplane enthusiasts.

KEYWORDS: avionics; low-cost; UAV; GPS; electronics; production

N01-148 TITLE: Very Low Cost, Lightweight IridiumTM / GlobalstarTM Communications Modules

TECHNOLOGY AREAS: Electronics

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMR-51

DESCRIPTION: With the recent decision by the US Government to become the dominant user of the IridiumTM satellite system, there could be a very significant capability for using either it or the GlobalstarTM system to permit near real-time, two-way communication and control of UAVs. What is required is both the hardware and the software that can provide this data communications capacity over these systems using very low cost components at the vehicle level. The onboard system should be capable of providing some form of non-exploitable, short-term (500 hr) secure encryption for transmission at data rates up to 10 K bytes / sec. The power requirement should be <3WDC, the complete system should weigh <8 oz, and the system should be reliable for >48 hours in a very high vibration environment.

PHASE I: Develop a proof of concept, breadboard, very low cost datalink system using either commercial SATCOM system. Demonstrate required data rates in the lab and examine worst case data rates that would be expected in the field. Include support documentation explaining how final flyaway cost will meet or exceed cost/weight/size/performance objectives. Provide 2 vehicle level systems for test and evaluation.

PHASE II: Design vehicle size prototype and demonstrate a 10K bytes/ sec data link between an airborne vehicle in a high EMI environment and a ground system stationed at >200nm. Develop brassboard system units and evaluate them in prototype vehicles. Provide 6 functional vehicle level units for test and evaluation. Estimate cost of production for 1000 lot size.

PHASE III: Demonstrate production capability with the construction and delivery of 25 functional units. Test 10 additional units airborne in an appropriate UAVs for uninterrupted periods >24 hours. Report their performance and project their reliability. Estimate final cost of production in lots of 1000.

COMMERCIAL POTENTIAL: The demonstration of very low cost sensor technology will enhance the capability to incorporate a vast array of new sensors into both consumer and industrial goods.

KEYWORDS: commercial SATCOM, UAV, very low cost, lightweight, datalink

N01-149 TITLE: Expendable Active Battle Damage Assessment Sensors

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: NSWC Dahlgren

OBJECTIVE: Develop and demonstrate a small low cost expendable active sensor that can detect and transmit battle damage information following strikes by special technology payloads.

DESCRIPTION: When special technology payloads are used, verification and / or Battle Damage Indications (BDI) can be difficult to obtain. Normally, BDI is based on observing target status before and after a strike. For non-explosive payloads, however, another form of BDI must be employed to assess payload effectiveness. Such a sensor must detect target responses in one or more electro-optical bands including infrared (IR), radio frequency (RF), and / or acoustic responses from the target or target area. Target responses must then be transmitted via tactical (satellite) data-links back to the on-scene commander using a scheduled time interval for up to 2 hours. The sensor used must have a maintenance cycle of at least 15 years and be capable of activation upon deployment without any electrical signal (autonomously). The sensor must be capable of surviving deployment from an airborne platform at an altitude of 1000 feet at airspeeds up to 500 knots.

PHASE I: Define requirements for active sensors based on electro-optical band of interest. Identify potential sensors, data links, and power supplies. Design a ballistic retardation and an activation device.

PHASE II: Integrate components into a cylindrical shape no larger than 6 ½ inches long by 2 ½ inches in diameter including the container. Conduct a static demonstration to verify the sensors ability to detect target changes. Conduct dynamic testing to verify the sensor's ability to withstand dispense / impact and to provide real time data on target status via a data link.

PHASE III: Conduct cost and risk reduction analyses and demonstrate producability of the BDA sensor/dat link package. Develop a production and implementation plan for integrating a few packages into each Tomahawk land Attck Missile during the standard TLAM maintenance cycle.

COMMERCIAL POTENTIAL: This sensor could be adapted as a low cost alternative for locating downed aircraft in remote areas.

KEYWORDS: Battle Damage Indicators, Battle Damage Assessment, sensors, satellite data link

Naval Supply Systems Command (NAVSUP)

N01-150 TITLE: Technology for Logistics Productivity

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: A component is determined to be obsolete when its commercial availability becomes limited or nonexistent. The government spends millions of dollars to emulate replacement parts, redesign systems and equipment, find alternative sources or invest in life of type buys. The objective of this topic is to identify, develop and demonstrate the replacement or upgrade of a Navy system, subsystem or equipment suffering from obsolescence. It may be an electronic, mechanical or electro-mechanical system, subsystem or equipment. The technology demonstration must also provide a clear cost avoidance over the current system or equipment's replacement/upgrade strategies and significantly contribute to total ownership cost reduction.

DESCRIPTION: Because of rapid changes in technology, functional and economic obsolescence are both significant contributors to the high life cycle costs of Navy systems. The Naval Supply Systems Command (NAVSUP), under the sponsorship of the Office of the Chief of Naval Operations (OPNAV), manages the Navy Logistics Productivity Program, which is focused on increasing the life cycle of Navy systems through technology insertion. The current efforts, two of which are funded through Phase III SBIR contracts, address electronic systems obsolescence. However, not all of the electronic spectrum is addressed and there are no initiatives that address mechanical or electro-mechanical systems. In addition to specific technological submissions for electronic, mechanical or electro-mechanical systems, NAVSUP is also looking for tools that will help reduce costs associated with the technology insertion program. Examples of these tools might include, but are not limited to, smart scanners, raster to vector conversion tools, and automatic code generators.

PHASE I: Develop an overall design, to include a technical specification that demonstrates feasibility.

PHASE II: Develop and demonstrate a prototype in a realistic environment. Conduct testing to provide feasibility over extended operating conditions.

PHASE III: Develop and deliver a final application of the technology for commercial and military use.

COMMERCIAL POTENTIAL: The product could be used in a broad range of military and civilian applications where obsolescence is a significant detractor. An example of dual use applicability could be components utilized in both military and commercial aviation.

REFERENCES:
1. Navy Logistics Research & Development Program, Gary Fitzhugh, Richard Comfort and James Fitzgibbon, availabale at http://www.nlc2000.org/papers/Fitzhugh.pdf
2. Government Initiatives to Solve Diminishing Manufacturing Sources/Material Shortages (DMSMS), available at http://www.gidep.corona.navy.mil/dmsms/dmsinfo.htm

KEYWORDS: Obsolescence; Electronics; Mechanical; Electro-Mechanical; Tools; Code; Scanner

N01-151 TITLE: Laboratory Convective / Steam Heat Test Apparatus

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT IV: NCTRF (Navy Clothing & Textile Research)

OBJECTIVE: Develop and demonstrate a test apparatus to measure the amount of heat that would pass through a fabric sample or composite when subjected to high levels of convective heat and steam. The apparatus should also be able to measure the temperature rise between layers of composite materials.

DESCRIPTION: Currently the Navy has no way of evaluating materials for their ability to protect against both convective heat and steam. Navy personnel have experienced burns during fire fighting due to the combined effects of convective heat and steam. Because there is no way to evaluate materials for their ability to protect under these conditions, to insure protection, Navy currently offers maximum protection at a high cost. With this test apparatus, the Navy will be able to evaluate numerous types of fire-protective materials at a reduced cost. For example, the Navy submarine force has a protective ensemble to protect against steam leaks. However, there is no way to evaluate new material composites to upgrade the suit unless suits are manufactured from numerous material combinations and subjected to high cost testing at the full scale steam facility. The apparatus shall have the following parameters:
- Temperature Range - Up to 1000 degrees F.
- Steam Condition - 0 PSI at 212 °F. (on face of material)
- Recording Device - The recording device shall have the capabilities of listing all temperatures / pressures every half second of apparatus use. Must also be capable of plotting the time temperature relationships of the sample.

PHASE I: Develop an overall design of the testing apparatus, to include materials, cost data and engineering drawings.

PHASE II: Construct prototype apparatus and demonstrate performance by testing 50 samples (to be furnished by the Navy Clothing and Textile Research Facility).

PHASE III: Develop and deliver a final testing apparatus for use by civilian and military testing laboratories.

COMMERCIAL POTENTIAL: The apparatus will become a standard means of evaluating material composites as they relate to the protection of personnel from heat and steam. The procedure would become a standard test for evaluation of protection for fire fighters and others subjected to this type of environment. Manufacturers and laboratories that work in these areas would procure the instrument. This device would reduce research costs and allow the procurement of cost-effective protective clothing with confidence that it will perform as anticipated. The reduced testing cost will benefit both military and civilian users.

REFERENCES:
1. National Fire Protection Standards NFPA 1971, 1976, 1991, and 1992.

KEYWORDS: Fire Fighting; Convective Heat; Steam; Protective Materials; Testing; Testing Apparatus

N01-152 TITLE: Environmentally Friendly Advanced Food Packaging

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT IV: NAVICP Code 077

OBJECTIVE: Develop and demonstrate biodegradable packaging films for Navy food services that degrade in the marine environment and function according to current food wrap performance specifications.

DESCRIPTION: The Marine Pollution Treaty does not allow plastics to be thrown overboard ships. Current food packaging contributes to plastic waste Navy ships generate, store and must ultimately dispose. The replacement of plastic material used to package food with biodegradable packaging materials will significantly reduce the burden of food packaging disposal. The Navy is most interested in meat and vegetable wrappings with barrier properties for oxygen and water vapor permeability. Wraps are needed that are strong and protect foods from moisture loss. Protection of precooked, preserved, frozen, or fresh foods, including meats, grains, vegetables, or beverages, will be considered during evaluation. The new packaging material should be marine biodegradable, non-pollutant, and non-toxic for food applications. Water solubility, film formability, viscosity, moldability, and biodegradability of the packaging product will be considered. The wrap will be a desirable alternative to traditional plastic wraps for food with properties that include odorless, toughness, strength, gas impermeable (oxygen), heat sealable, and machine processable.

PHASE I: Develop a marine biodegradable food packaging item to meet the performance specifications for military use. The material, product design and manufacturing process all need to be considered.

PHASE: Demonstrate an optimum material and processing method, with a sample passing storage studies and performance tests.

PHASE III: Produce and market new product.

COMMERCIAL POTENTIAL: These products will be directly used by the Navy and other military services, and can be transitioned to the commercial sector where food packaging items are utilized (e.g., fast food establishments, school cafeterias, restaurants).

REFERENCES:
1. Biodegradable Polymers and Packaging, Ching, C., Kaplan, D., Thomas, E., Technomic Publishing Co., Inc., Lancaster, PA, 1993.
2. Simulated Marine Respirometry of Biodegradable Polymers, A. Allen, J. Mayer, R. Stote, D. Kaplan, Journal of Environmental Polymer Degradation, Vol. 2, No. 4, 1994.
3. Polymers From Renewable Resources, R. Gross, C. Scholz, American Chemical Society Symposium Series, December 2000.

KEYWORDS: Biodegradable; Marine Environment; Packaging; Food; Barrier; Wrap

Naval Air Systems Command (NAVAIR)

N01-153 TITLE: Low Volatile Organic Content (VOC) Solid Film Lubricant

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: PEO, Air, ASW, Assault & Special Mission

OBJECTIVE: Develop a low VOC content solid film lubricant, which contains no lead or antimony and meets the performance requirements of MIL-L-23398 and/or MIL-L-46147.

DESCRIPTION: Solid film lubricants are used in a variety of applications. For example, they aid in the assembly and subsequent disassembly of mated parts (such as threaded fasteners, turbine discs, and blade roots), and in the prevention of galling and fretting of aircraft engine parts. Recently, a solid film lubricant has been developed that contains no lead or antimony but it does not meet the endurance life requirement in the MIL-L-23398 specification. Furthermore, it contains high levels of VOCs. These VOCs promote the application of the lubricant but their emissions contribute to environmental air pollution.

PHASE I: Develop a low VOC content solid film lubricant that meets the performance requirements of MIL-L-23398 and/or MIL-L-46147. Assess the impact of the organic compounds on surface contact and adhesion of a lubricant. Address the practicality and feasibility of reformulating the solid film lubricant. Select organic compound(s) for a Phase II reformulation of a low VOC lubricant

PHASE II: Conduct laboratory tests of varying concentrations of the low VOC compound(s) on the wear, corrosion, and galling of a solid film lubricant. Identify the concentration of the low VOC compound(s) that give the best performance. Reformulate the lubricant and conduct performance evaluation using the requirements of MIL-L-23398 and/or MIL-L-46147. Assess the effect of this low VOC solid film lubricant on the Navy's overall VOC emissions. Refine lubricant production processes.

PHASE III: Conduct full-scale demonstration.

COMMERCIAL POTENTIAL: Low VOC solid film lubricants have direct replacement to current solid film lubricants use in military and commercial markets to prevent wear, galling and fretting, and to assist in assembly and disassembly of parts.

REFERENCES:
1. MIL-L-23398, Lubricant, Solid Film, Air-Cured, Corrosion Inhibiting, NATO Code Number – 749
2. MIL-L-46147, Lubricant, Solid Film, Air Cured (Corrosion Inhibiting)

KEYWORDS: Environmentally Friendly; Solid Film Lubricant; Dry Film Lubricant; Air-Cured; Corrosion Protection; Volatile Organic Compound

N01-154 TITLE: Probabilistic Mission/Engine Duty Cycle Analysis

TECHNOLOGY AREAS: Air Platform

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT IC: PEO, Tactical Aircraft Programs

OBJECTIVE: Develop an analytical method and tool to generate both a deterministic and probabilistic mission mix in order to evaluate flight mission data and engine duty cycles for low and high cycle fatigue drivers.

DESCRIPTION: Mission analysis data is essential in determining low and high cycle fatigue life prediction for engine components. Currently, a single mission profile is used to represent all variations for a particular mission type. This deterministic profile is based on an average mission and does not accurately reflect all of the critical operational conditions. A probabilistic mission/engine duty cycle analysis program will address this deficiency by statistically modeling required parameters (i.e., power level angle, altitude, airspeed, rotor speeds, turbine temperatures, after burner lights, and variable guide vane angles) and translate mission profiles into a statistical representation. This representation will be used to increase the fidelity of the life assessment process. Developing this analytical method/tool will provide an accurate representation of how specific aircraft are used. The probabilistic mission/engine duty cycle analysis will reduce the engineer's workload, increase responsiveness to customer(s), and produce a high quality analysis in consistent fashion across all military platforms.

PHASE I: Develop technologies and software that provide deterministic and probabilistic analysis programs. The software must be able to accept various input formats, provide deterministic and probabilistic/statistical analysis tools, display data/results in graphical form, and output results in both soft and hard formats.

PHASE II: Expand the development, test and demonstration of the software program by analyzing actual field data and identify an average mission mix and engine duty cycle based on a deterministic approach. The contractor will provide operational software, source code, documentation, and user manuals.

PHASE III: Transition the analysis to generate a probabilistic mission mix and engine duty cycle. The contractor will provide final operational software, source code, documentation, user manuals, and if necessary, on-site training.

COMMERCIAL POTENTIAL: This software program could be used by commercial airlines to monitor/develop their engine/aircraft usage.

REFERENCES:

1. Functional Specification, Automated Engine Cycle Analysis, 10 March 1992

KEYWORDS: High Cycle Fatigue; Low Cycle Fatigue; Probabilistic; Engine Duty Cycle; Mission Analysis; Engine Flight Parameters

N01-155 TITLE: Coupled Vertical/Short Takeoff and Landing (VSTOL) Down Wash-Ground Effect and Ship Air Wake Turbulent Flow Simulation Model

TECHNOLOGY AREAS: Air Platform

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: NAVAIR 1.0 (Program Management for Acquisition and Operations)

OBJECTIVE: Develop a modeling tool based on computational fluid dynamics (CFD) to simulate the interaction of VSTOL flow and the unsteady air wake produced by the super structure of the ship for the purpose of predicting and enhancing VSTOL aircraft dynamic interface (DI) performance

DESCRIPTION: VSTOL aircraft such as the JSF and AV-8B encounter unique challenges during shipboard (DI) operations (takeoff and landing) due to the interaction of the propulsion-generated down wash and the unsteady air wake generated by the ship. Operating envelopes, also known as wind-over-deck (WOD) envelopes, are currently developed through at-sea trials. These trials are quite costly because they require the dedicated use of a ship, aircraft, and the personnel to support the test. In addition, the WOD envelopes that result from such tests may be overly restrictive if the wind conditions are too mild during the test period. Safety is also an issue during these trials since the aircraft have not been flown in the trial wind conditions before. An innovative approach is sought to model the coupled airflow of a ship/VSTOL-aircraft combination to predict DI performance. The general approach should use time-accurate CFD to predict the overall flow field. The tool should be flexible enough to model a complete 360° azimuth of wind conditions at wind speeds from 15 to 30 knots. Results should include predictions of DI performance (for example pilot workload). The tool must be validated at each stage of development. The anticipated validation process includes the following elements: validation of VSTOL aircraft in ground effect predictions; validation of ship air wake predictions; validation of coupled VSTOL/ship flow field predictions; and validation of WOD envelope predictions. Validation efforts may use both wind tunnel and flight data.

PHASE I: Develop and validate the initial CFD tools to predict the VSTOL-in-ground-effect flow field and the ship air wake flow field. Develop the conceptual approach to model the coupled flow field and WOD predictions.

PHASE II: Develop the tools and approach to model the coupled flow. Develop the tools to generate the WOD operating envelopes. Validate the tools for one VSTOL-aircraft/ship combination

PHASE III: Upon validation of the tools for one aircraft/ship combination, the tools/process can be transitioned to industry and government to predict and enhance DI performance for current and future VSTOL aircraft.

COMMERICAL POTENTIAL: The modeling tools developed to simulate aircraft ground effects could be used for commercial helicopters such as those used by the Coast Guard, police, and medical evacuation helicopters in order to enhance DI performance. The result would be improved safety by identifying possible hazardous areas before the aircraft will encounter them in real life and by improving pilot training through enhanced real-time simulation. The tools developed could also be used to aid in the design of commercial Vertical VSTOL aircraft.

REFERENCES:
1. "Time Accurate Computational Simulations of Ship Air Wake," AIAA paper 2000-4126 2. Joint Ship Helicopter Integration Process (JSHIP) program documentation

KEYWORDS: Vertical/Short Takeoff and Landing (VSTOL); Computational Fluid Dynamics (CFD); Air Wake; Dynamic Interference (DI); Ground Effect; Wind Over Deck

N01-156 TITLE: Nonlinear Combustion Stability Prediction of Solid Rocket Motors

TECHNOLOGY AREAS: Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT ID: PEO-T, Tactical Aircraft Programs

OBJECTIVE: Develop and validate a computational design tool that will predict the combustion stability characteristics of realistic full-scale solid propellant rocket motors. The code should account for variations in three-dimensional grain designs, ballistic parameters, and propellant formulations. The new code should be able to predict linear as well as nonlinear combustion instability behavior, including limiting oscillatory amplitudes, triggering levels to cause instabilities, nonlinear particle damping, and three-dimensional mixed acoustic mode analysis.

DESCRIPTION: The Navy, Air Force, Army, and to some extent NASA, currently depend upon the Air Force funded Solid Propellant Rocket Motor Performance Computer Program (SPP) to evaluate the acoustic stability of solid rocket motors (reference 1). The SPP stability prediction model is limited to linear stability analysis. Recently, numerous development rocket motors have experienced stability concerns that are outside the predictive capability of the current stability code. It is proposed to increase the capability of the design code to include various nonlinear predictive capabilities coupled to axi-symmetric, 2-D and three-dimensional grain design and ballistics. Nonlinear behaviors include limiting oscillation amplitude, pulsing thresholds, metal distributed combustion, nonlinear particle damping, nonlinear response and mixed acoustic mode analysis. All of this will be performed using a time dependent three-dimensional internal ballistic model. The ballistic model will include both three-dimensional grain design and three-dimensional acoustic fields. The stability model will have the capability to predict the nonlinear acoustic stability of both longitudinal and tangential acoustic modes. The code to be developed will be a practical industrial engineering tool for motor design as opposed to a research tool more suited for a university environment.

PHASE I: Perform a feasibility study to determine the physical models for inclusion into the code to predict nonlinear solid rocket stability. One potential source for physical models is from a recent effort funded by the Office of Naval Research (ONR) and the Ballistic Missile Defense Organization (BMDO) which developed three distinct methodologies to predict non-linear stability (references 2-6). The approach chosen in Phase I should consider not only the physical models, but also the suitability for inclusion in a three-dimensional motor stability analysis combined with full up ballistic prediction.

PHASE II: Implement the nonlinear analyses selected in Phase I into a usable computational engineering tool. Items for inclusion should include nonlinear response, limiting amplitudes, pulsing thresholds, distributed metal combustion, two phase flow, nonlinear particle damping, mixed mode acoustic analysis, complicated flow field effects. Include traditional linear stability prediction.

PHASE III: Refine the code for commercial use, including operational manuals, test cases, and graphical interfaces and provide a variety of versions for different computer platforms.

COMMERCIAL POTENTIAL: The program will have widespread use throughout the solid rocket motor community for both research and development and will be used in industry, government and university environments. Solid rocket motors of all sizes and applications will benefit from this work including intercontinental ballistic missiles (ICBMs), tactical systems, ground based defense systems and space motors. Prime defense contractors, solid rocket contractors, intelligence agencies and sub-contractors will be interested in licensing the software. The technology can also be extended to other combustion devices such as turbine engines for both military and commercial applications.

REFERENCES:

1. “A Computer Program for the Prediction of Solid Propellant Rocket Motor Performance (SPP), Vol. VI, Standard Stability Prediction Program for Solid Rocket Motors (SSP),” G. R. Nickerson, F. E. C. Culick, and L. D. Dang, Air Force Rocket Propulsion Laboratory, Edwards Air Force Base, California, AFRPL-TR-83-017, September 1983.
2. "Nonlinear Combustion Instabilities and Stochastic Sources" V.S. Burnley, Ph’D Thesis, California Institute of Technology, Pasadena, CA, 1996.
3. “Some Influences Of Nonlinear Energy Transfer Between The Mean Flow And Fluctuations,” F.E.C. Culick, G.C. Isella, California Institute of Technology, Proceedings of the JANNAF Combustion Meeting, CPIA-PUB-662-Vol-II, Oct 97.
4. “Nonlinear Unsteady Combustion Of A Solid Propellant,” G.A. Flandro, University of Tennessee, Proceedings of the JANNAF Combustion Meeting, CPIA-PUB-662-Vol-II, Oct 97.
5. “Two-Phase Turbulent Flow Interactions In A Simulated Rocket Motor With Acoustic Waves, W. Cai and V. Yang, Pennsylvania State University, Proceedings of the JANNAF Combustion Meeting, CPIA-PUB-662-Vol-II, Oct 97.
6. "Some Influences of Noise on Combustion Instabilities and Combustor Dynamics,” F.E.C. Culick and C. Seywert, 36th JANNAF Combustion Meeting, Cocoa Beach, Florida, Oct 99.

KEYWORDS: Combustion Stability; Solid Rockets; Grain Design; Ballistics; Performance Prediction; Nonlinear Acoustics

N01-157 TITLE: Transparent, Electrically Conductive Coatings for Infrared Windows

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: PEO(T), Tactical Aircraft Programs

OBJECTIVE: Develop durable, infrared-transparent, electrically conductive coatings for windows and domes of forward looking infrared (FLIR) sensors, infrared search and track (IRST) sensors, and infrared seekers.

DESCRIPTION: Infrared sensors are adversely affected by stray radio frequency and microwave radiation. Electromagnetic interference (EMI) can generate spurious signals or high levels of noise in the infrared detector. Therefore, EMI shielding is desired or required on sensor windows. Metallic meshes for EMI shielding significantly degrade the optical signal passing through the window and tend to be easily eroded by high-speed impacts of rain and sand. A durable, continuous, electrically conductive, infrared-transparent film would be an ideal substitute for a metallic mesh. A conductive coating, that allows electromagnetic blending of the sensor compartment with the rest of the airframe, can help to reduce overall electromagnetic signature. A continuous coating will reduce total ownership cost of an infrared window because the coating should be less expensive than a metallic mesh and last longer.

Existing conductive, visibly transparent materials, such as indium tin oxide, are not sufficiently transparent in the infrared region. P-type semiconductors, such as copper aluminum oxide, offer the possibility of being transparent at infrared wavelengths and have adequate conductivity for electromagnetic shielding. To reject 99 to 99.9 percent of radio frequency energy, a thin conductive coating should have a sheet resistance of < or = 10 ohms/square. The conductive layer should be part of an antireflection coating that achieves an overall mean transmittance of > or = 80 percent at visible wavelengths, 1–1.5 µm, and 3–5 µm for a sapphire or multi-spectral zinc sulfide window.

PHASE I: Identify candidate coating materials that are electrically conductive and provide infrared transparency at 3–5 (or 8–10) µm wavelengths. Deposit thin films of candidate materials on a nonconductive substrate such as glass and measure the electrical sheet resistance or radio frequency reflection. Deposit thin films on inexpensive, infrared-transparent substrates such as silicon and measure the infrared transmittance. Identify coating material(s) for Phase II development. Assess the feasibility, practicality and technical risk associated with depositing a coating on infrared sensor windows. Goals are a sheet resistance of < or = 10 ohms/square and a mean transmittance of > or = 80 percent at visible wavelength, at 1–1.5 µm and at 3-5 or 8-10 µm.

PHASE II: Optimize material composition for high electrical conductivity, high infrared transparency, and good adhesion. Demonstrate deposition on sapphire (for 3-5 µm transparency) or zinc sulfide (for 8-10 µm transparency) substrates. Measure the conductivity and transmission of coated substrates. Evaluate coated substrates stability with respect to temperature excursions and exposure to sunlight. Determine rain and sand erosion resistance of coated disks. Incorporate the conductive layer into an antireflection coating. Identify final coating and coating deposition development requirements for Phase III.

PHASE III: Finalize coating deposition process. Deposit coatings on flat surfaces and hemispheres up to 200 mm in diameter. Demonstrate transparency and electrical conductivity. Conduct full-scale evaluation using an infrared sensor. (Note: the infrared sensor will be identified during Phase III.)

COMMERCIAL POTENTIAL: Transparent, conductive coatings are used in flat panel displays and in photovoltaic cells to convert sunlight into electricity. The combination of p- and n-type transparent semiconductors offers a unique opportunity for generating ultraviolet radiation from a hetero-junction diode at room temperature [2].

REFERENCES:

1. H. Kawazoe, M. Yasukawa, H. Hyodo, M. Kurita, H. Yanagi and H. Hosono, "p-Type Electrical Conduction in Transparent Thin Films of CuAlO2," Nature, 389, 939-942 (1997).
2. H. Kawazoe, H. Yanagi, K. Ueda and H. Hosono, "Transparent p-Type Conducting Oxides: Design and Fabrication of p-n Heterojunctions," Mater. Res. Soc. Bull. 25, 28-36 (2000)
3. D. C. Harris, Materials for Infrared Windows and Domes, SPIE Press, Bellingham, Washington, 1999, pp. 207-210.

KEYWORDS: Conductive Coating; Infrared Window; FLIR Window; Electro-Optic Sensor; EMI Shielding; P-Type Semiconductors

N01-158 TITLE: Enhanced Propeller Visibility

TECHNOLOGY AREAS: Air Platform

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT IC: PEO-T, Tactical Aircraft Programs

OBJECTIVE: Develop a method for insuring all light condition visibility/awareness of aircraft propellers to insure aircrew safety.

DESCRIPTION: The E-2C and C-2A are the only remaining two propeller driven aircraft deployed on U.S. Navy aircraft carriers. High tempo 24 hour day and night flight operations demand that good safety procedures be adhered to and followed by all aircraft carrier personnel. The E-2C program desires to enhance carrier personnel safety by providing innovative aids that increase personnel awareness of rotating propellers/rotors at night and in low visibility conditions. The goal is to reduce the risk of carrier personnel being inadvertently struck by rotating propellers or rotors. The aids should make use of but are not limited to advanced computer hardware and software, lightning, paint and sound technologies. The approach may be one or a combination of technologies. The approach should consider keeping weight and power requirements to a minimum and satisfy the carrier E3 environment requirements if applicable. The approach should be easily incorporated on ship, aircraft or personnel as required. The goal is to implement this technology into carrier flight operations/procedures in two years or less.

PHASE I: Provide a design concept, including theoretical performance specifications in all weather/light conditions, which would be prototyped and demonstrated during Phase II.

PHASE II: Finalize the design and fabricate a functional prototype that may be demonstrated on a selected propeller driven aircraft. Performance tests addressing the specifications reported in Phase I should be conducted.

PHASE III: Improve functional prototype demonstrated in Phase II to a reliable airworthy maintainable component and/or system. Ensure that the technology produced during Phase II can be effectively produced and incorporated efficiently into propeller driven aircraft and helicopters.

COMMERCIAL POTENTIAL: Aircraft manufacturers (both civilian and military aircraft) would incorporate this technology to provide additional safety for ground and air crews required to work in close proximity of propeller aircraft. Commercial airlines flying commuter aircraft and helicopter operators would incorporate this technology to reduce the risk of propeller/rotor strikes and improve safety.

KEYWORDS: Propeller; Visibility; Rotors; Safety; Sensors; Software

N01-159 TITLE: <u>Material Encoded Textures with Computer Generated Forces (CGF)</u>

TECHNOLOGY AREAS: Information Systems, Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: NAVAIR 1.0, (Program Management for Acquisition and Operations)

OBJECTIVE: Using the newer high-end geo-specific scene rendering technologies develop a Computer Generated Forces/Semi-Automated Forces (SAF) System that is not constrained by current polygon/vector based methods.

DESCRIPTION: Currently, the largest cost issue facing training system developers is creating highly correlated descriptions of the training environments in several different formats in parallel to support several different networked simulators and multiple sensors within a simulator. New technologies are emerging that hold promise in providing more realistic simulation by increasing correlation between the human training systems and the computer-generated forces at a reduced cost.
An example would be pixel-level material encoded textures. For multiple sensor scene generation within a human-in-the-loop-training simulator, the issue of multiple formats/versions of the database is addressed thru the use of an Open Commercial format (Terra-page) that supports the Navy developed concept of pixel level material encoded textures. The pixel level material encoded textures allows positional and spatial correlation for simulations of out-the-window (OTW), forward looking infrared (FLIR), night vision devices (NVD), synthetic aperture radar (SAR), and mission function (MF) through the use of interrupting the sensor response of the material(s) encoded at each pixel from a common copy of the database.
However, the SAF systems used by all the services do not use textures. Currently, polygons/vectors representations determine the environment impact on the computer generated entity, such as mobility, route finding, etc. Because polygons are several magnitudes larger than the pixels, they inhibit the SAF system correlation with pixel level based human systems and thus cannot provide a “Fair Fight” scenario. By applying the new knowledge such as pixel level material encoded textures into an existing SAF framework it would increase its correlation with human systems and decrease associated program costs. Assuring correlation (both location and spatial) through the use of the exact same data, reduces production costs and shortens development schedule by removing redundant efforts in data transformation by using the exact same description of the environment.

PHASE I: Assess the current polygon/vector based SAF system database structures and architecture to determine the ability of a system to be modified to integrate/interface the new technologies. Identify system functions that will require modification or development. Define a hardware and software design concept for development in Phase II. Technologies to be applied/developed would leave intact the legacy system's cognitive and behavior modeling system.

PHASE II: Develop the architecture, algorithms, and hardware for system operation. Assemble and install a prototype system by modifying an existing SAF system. Demonstrate proper operation of the SAF to include, mobility, rendering, road following, collision, and required other mission functions as required. Provide final design for Phase III development with improved performance. The developed SAF system should result in significantly improved "Fair Fight" scenario correlation.

PHASE III: Complete system development. Incorporate route finding and performance enhancement modifications. Demonstrate a full scale SAF system. Refine the software into production code.

COMMERCIAL POTENTIAL: The commercial potential will be a run-time license of the modified CGF software to use this capability as part of a delivered training system. The software capability lends itself to the next generation of game engine in the commercial market.

KEYWORDS: Computer Generated Forces (CGF); Sensor Texture; Joint Integrated Mission Model (JIMM); Human -in-the-Loop Simulation; Semi-Automated Forces (SAF); Texel

N01-160 TITLE: Aluminum Honeycomb Panel/Substructure Replacement Initiative

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a cost-effective process for the fabrication of aircraft panels and sub-structure (that utilize aluminum honeycomb core construction) that meet, or exceed, the minimal life limit of 60 months for delamination and/or corrosion.

DESCRIPTION: The F-14 and EA-6B aircraft make extensive use of a structural fabrication technique known as honeycomb sandwich construction in the manufacture of flight control surfaces and aircraft sub-structures. The design consists of two thin aluminum (or titanium) skins bonded using adhesive to an aluminum honeycomb core. This construction method provides the optimum mix of lightweight and structural strength; however, these components routinely suffer from core corrosion and skin delamination due to water intrusion, improper workmanship, damaging maintenance actions, and normal environmental stress. Honeycomb bonded panels are expensive to maintain and are repaired or refurbished on a regular basis at the Navy depots. Current approaches only allow for the use of remanufactured panels. This is costly and leads to additional failures over time. The goal of this initiative is to analyze, design, and develop alternative processes for replacement aluminum and titanium skins and honeycomb core that will resist corrosion and delamination for up to 60 months. It also seeks to determine the cost-effective use of a “drop in” core that will greatly streamline the panel/sub-structure manufacturing process. The contractor must take into consideration the use of such materials as aluminum and titanium in the fabrication of replacement skin panels. The contractor’s approach must address the qualification of adhesives and bonding materials if they differ from those used in the current fabrication process.

PHASE I: Develop the feasibility of a cost-effective process for the fabrication of replacement of sub-core aluminum materials. Propose changes to existing process specifications and identify qualification test requirements for the recommended fabrication process.

PHASE II: Develop the process for fabrication of replacement sub-core aluminum materials and re-qualify changes to the existing process specification. All processes that have been recommended during Phase I will be fully evaluated and verified by test case. Include all qualification testing such as laboratory, installed ground, and flight-testing. The result of this phase is a detailed process for the fabrication of replacement skin panels.

PHASE III: Restore all aircraft flight control surfaces and substructures for the F-14 and EA-6B that have been qualified during Phase II. Perform initial Fleet reliability tests.

COMMERCIAL POTENTIAL: The aerospace industry is faced with the same problems and issues related to aircraft flight control surfaces as the F-14 and EA-6B aircraft. The problem of commercial aviation is worse due to the high amount of flight hours placed on the airframe and the need to meet the highest safety. Many older commercial aircraft such as the Boeing 707, 727 and 737 series of aircraft have expected service lives of 30+ years. Some of these aircraft are out of production and the ability to find ready replacement panels at reasonable costs or cannibalize skin panels from out-of-service aircraft makes this technology appealing to the original equipment manufacturer and second sources. Additionally, lightweight aluminum sub-cores can be used in the construction industry where structural strength and durability as well as reduced weight are necessary elements of design (such as glass atriums and large dome construction).

REFERENCES:

1. “Corrosion and Corrosion Fatigue of Aircraft Materials” – Lehigh University, Bethlehem, PA, R.P. Wei and D.G. Harlow, Feb 96, NTIS AD-A307 471/3INZ

2. “Fretting Corrosion in Airframe Riveted and Pinned Connections” – Vanderbilt University, Nashville, TN, G.T. Hahn and G.A. Rubin, Mar 98, NTIS AD-A341 669/0INZ

KEYWORDS: Aluminum Honeycomb Core; Aircraft Skins; Adhesive; Delamination; Corrosion; Sandwich Construction

N01-161 TITLE: Active and Passive Reduction of Noise Caused by Bone Conduction to the Head of U.S. Navy Deck Crew Personnel with Helmets

TECHNOLOGY AREAS: Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: NAVAIR 1.0, (Program Management for Acquisition and Operations)

OBJECTIVE: U.S. Navy personnel performing aircraft operations (or maintenance) on the deck of the ship are exposed to excessive noise from the aircraft engines during catapult launches with aircraft operating at full after burner, arresting gear recoveries, when full after burner is again applied, or during AV-8B short take off and vertical landing (STOVL) operations on "L" class ships. The levels of noise are so high that the aircraft noise is not only transmitted through the air to the deck crew's ear canal, but it also conducted to the person's skull and through the bone structure to the inner ear. The need to carefully quantify bone and conduction pathways in the human head as a function of frequency is sought. Pathways of conduction need to be carefully mapped. New technology is sought for hearing protection to reduce or attempt to eliminate bone-conducted noise that interferes with speech intelligibility and causes hearing loss to warfighter personnel. New ideas are sought to provide technology in the various forms that can be used with existing deck crew protective equipment. Compatibility with electromagnetic interference (EMI) generated by the ship or the aircraft is important. The reduction of noise to the deck crew person's ear caused by bone conduction is the objective of this program.

DESCRIPTION: Current U.S. Navy deck crew helmets (usually referred to as "cranials") use a circum-aural passive hearing protector consisting of an ear cup assembly with ear seal or cushion. Most deck crew helmets do not have communications equipment. Some personnel who operate near the catapult launching systems on the Nimitz class aircraft carriers experience excessive noise and vibration during the launch of a tactical aircraft with full engine after burners lighted. There is currently no protection available to mitigate this excessive sound pressure and the resulting conduction of the noise internally to the inner ear. Further, the conductive path(s) through the body to the ear are not documented or understood. Ear cup and earplug technology do not appear to help dampen this type of noise. Deck crew personnel currently use double hearing protection by inserting foam earplugs into the ear canal and then donning their helmet with passive ear cup assemblies. The use of full body suits to dampen the vibration has been discussed, but its use is not feasible in a wartime operation in a high temperature region of the world. Application of sensors or active vibration control in a cranial device has been considered, but the proper locations of the sensors are in question. Frontal areas of the face would be difficult to protect since vision and field of view are important. As new high performance aircraft are added to the Fleet, the noise generated by their more powerful engines is producing more noise on the deck of the ship. For the purpose of this program, 85-dB (A) for a maximum of 8 hours per day with 3 dB doubling will be used as the allowable threshold. This will assume that the personnel will be exposed to at least 16 hours of "quiet time" each day. Some deck crew personnel operate in overall noise levels up to 150 dB (A) (ambient unprotected levels) during aircraft launches with after burner operational and aircraft arresting gear recoveries. Some of these personnel are required to conduct voice communications with the air operations officers in the "Island" of the ship. Current deck crew helmets (cranials) when combined with off-the-shelf foam earplugs can provide up to approximately 30 dB (A) of protection. The Naval Aviation Systems Command will provide reports of the latest noise measurements taken on the ground and on a carrier and Landing Ship, Helicopter Assault (LHA) class ship if they are releasable to the public. A system approach that addresses the bone conduction noise problems as described above is sought.

PHASE I: Propose new design approaches to protect naval deck crew personnel from the conduction of noise through the skull to the inner ear. Establish a protocol for determining the path(s) of bone-conducted noise to the human's inner ear. Develop a preliminary conceptual design for deck crew personnel.

PHASE II: Map the path of the bone conduction to the inner ear and document with testing and a report. Perform a trade study and prepare concepts that are believed to provide bone conductive attenuation for deck crew personnel exposed to 150 dB (A). Develop conceptual designs of the phase I approaches and fabricate two prototypes. Prototypes shall be fabricated and preliminary testing conducted to verify that the bone conduction could be reduced or eliminated.

PHASE III: The developed prototypes will be evaluated with existing deck crew helmets (cranials) and tested in the fleet by the U.S. Navy. After successful demonstration and acceptance by the fleet, additional work will be pursued to integrate the technology into the existing personal protective equipment worn by the flight deck crew. This technology will also be shared with the selected Joint Strike Fighter (JSF) and other advanced helmet contractors for implementation into their proposed future helmet systems.

COMMERCIAL POTENTIAL: Foreign military service personnel with aircraft carriers are in need of equipment that can reduce bone conduction caused by high noise. The technology could also be used by commercial contractors using heavy industrial equipment such as "jack hammers" which generate excessive noise.

REFERENCES:

1. ANSI S12.6-1997, "Methods for Measuring the Real-Ear Attenuation of Hearing Protectors"
2. "Bibliography On Hearing Protection, Hearing Conservation, and Aural Care, Hygiene and Physiology, 1831-1999"; E-A-R 82-6/HP, E.H. Berger, M.S., January 25, 1999
3. "The Noise Manual", Fifth Edition , The American Industrial Hygiene Association, May 2000

KEYWORDS: Bone Conduction; Noise Conduction; Active Hearing Protection; Cranial Conduction; Controlling Noise Conduction; Human Skull

N01-162 TITLE: <u>Active Noise Reduction Earplug and Improved Speech Intelligibility for Aircrew and Deck Crew Personnel with Helmet Integrated Communication Systems</u>

TECHNOLOGY AREAS: Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: NAVAIR 1.0, (Program Management for Acquisition and Operations)

OBJECTIVE: Speech communication systems used by U.S. Navy and Marine Corps personnel in the aircraft cockpit and aircraft operations (or maintainer) personnel on the deck of the ship are extremely difficult to understand due to excessive background noise from the aircraft engines, environmental control system (ECS) equipment in the cockpit, and wind noise over the canopy or over the deck of the ship. New active noise reduction communication systems (active earplugs and other new technology) combined with passive hearing protective/attenuation technology is sought to reduce or attempt to eliminate ambient noise that interferes with speech intelligibility and causes hearing loss to warfighter personnel. New ideas and technology are sought to provide active noise reduction technology in the form of an earplug that can be inserted under a passive ear cup or helmet assembly. In addition, new hearing protection or sound attenuation technology is needed to reduce ambient noise which leaks past the helmet ear seal and ear cup into the user's ear canal. New earplug designs, better fit, ease of installation by the user with minimal training, repeatable performance in both male and female personnel of diverse races and ages, improved communications, compatibility with electromagnetic interference (EMI) generated by the ship or the aircraft, and the reduction of noise to the user's ear canal during speech communications by both the aircrew and the deck crew personnel are the objectives.

DESCRIPTION: Current U.S. military helmets use a circum-aural passive hearing protector consisting of an ear cup assembly with ear seal or pad and incorporate communication earphone elements at each ear cup and a microphone mounted to the helmet to permit voice communications. In some cases, aviation personnel and deck crew personnel use double hearing protection by inserting foam earplugs into the ear canal and then donning their helmet with passive ear cup assemblies and earphone elements. This additional protection requires them to increase the volume of their communication system and the speech communications is distorted. In addition, the very high levels of ambient noise generated by operational aircraft on the deck of the ship are fed back through the microphone. As new high-performance aircraft are added to the Fleet, the noise generated by their more powerful engines is producing more noise both on the deck of the ship and in the aircraft cockpit. This makes speech intelligibility difficult and can result in permanent hearing damage to these personnel depending upon the exposure levels and the duration of exposure. For the purpose of this program, 85 dB (A) for a maximum of 8 hours per day with 3 dB doubling will be used as the allowable threshold. This will assume that the personnel will be exposed to at least 16 hours of "quiet time" each day. Some deck crew personnel operate in overall noise levels up to 150 dB (A) (ambient unprotected levels) during aircraft launches with after burner operational and aircraft arresting gear recoveries. Some of these personnel are required to conduct voice communications with the air operations officers in the "Island" of the ship. Aircrew personnel in the cockpit can operate in overall noise levels up to 120 dB (A) (ambient unprotected noise) caused by a combination of engine noise, ECS noise and wind noise. Some aircrew personnel use foam earplugs in addition to the helmet, however this requires them to increase the volume of the communication system and speech intelligibility is sacrificed. Current deck crew helmets (cranials) when combined with off-the-shelf foam earplugs can provide up to approximately 30-dB (A) of protection. However, communication speech intelligibility is also compromised by the use of the standard foam earplug. All aircrew personnel in cockpits and deck crew personnel for the purpose of this program use helmet mounted communication systems. The Naval Aviation Systems Command will provide reports of the latest noise measurements taken on the ground and on a carrier and Landing Ship, Helicopter assault (LHA) class ship if they are releasable to the public. A system approach that improves the hearing protection and speech intelligibility for users that operate with communications as described above is sought. Approaches combining active earplug technology with passive technology are encouraged. Protective equipment that is easy to don and doff and to fit to the user with minimum training is very important. Equipment compatibility with aircraft and ship electromagnetic interference (EMI) is very important. Combinations of different hearing protection and speech intelligibility technologies to obtain at least 50 dB (A) attenuation at the user's ear for the deck crew personnel (with communications) and at least 40 dB (A) for the aircrew personnel with communications is the requirement of this program.

PHASE I: Propose new design approaches using existing technology for hearing protection to be worn by naval aviators and deck crew personnel who use communication systems. This shall address both microphone and active noise reduction (ANR) technology as well as improved ear seal and ear cup designs. Identify the difference in performance between custom-fit and foam earplugs. Compare new types of proven materials available, different types of aviator communication systems, new technology ideas, and mixes of different attenuation technologies. Fit to all users (male, female, various races, various ages) should be addressed. Data on new speech intelligibility technologies shall be included in the study along with the proposed recommended hearing protection. A conceptual design shall be developed for deck crew personnel with communications at the completion of Phase I.

PHASE II: Perform a trade study of aircrew hearing protective systems that provide at least 40 dB (A) of attenuation for the aircrew personnel with communication systems and a minimum of 50 dB (A) of attenuation for deck crew personnel without communications shall be used to develop demonstrable prototypes. Develop detailed designs for the phase I concept and fabricate two prototypes. According to the United States Navy defined frequency spectrum, prototypes of these configurations shall be fabricated and preliminary testing conducted to verify the speech intelligibility per ANSI S3.2-1989 (R1999) and noise attenuation per ANSI S12.6-1997 (Real Ear Attenuation at Threshold) per USN defined frequency spectrum. Six final systems shall be fabricated for government evaluation on deck crew and aircrew personnel in the fleet.

PHASE III: The developed system(s), one with communications for the aircrew and one for deck crew without communications, will be integrated into the existing helmets and tested in the Fleet. After successful demonstration and acceptance by the Fleet, an ECP to the existing personal protective equipment will be prepared to transition this equipment into the Fleet. This technology will also be shared with the selected Joint Strike Fighter (JSF) and other advanced helmet contractors for implementation into there proposed future helmet systems.

COMMERCIAL POTENTIAL: Commercial aircraft pilots and ground crew personnel using communication systems are currently in need of new improved hearing protective equipment that provides improved speech intelligibility. All the U.S. and foreign military service personnel are in need of new or improved hearing protective communication equipment. The technology could also be useable by homeowners who wish to listen to music with minimal background noise and commercial contractors using heavy industrial equipment that generate excessive noise.

REFERENCES:

1. ANSI S3.2-1989 (R1999), "Method for Measuring the Intelligibility of Speech Over Communications Systems"
2. ANSI S12.6-1997, "Methods for Measuring the Real-ear Attenuation of Hearing Protectors"
3. "Bibliography On Hearing Protection, Hearing Conservation, and Aural Care, Hygiene and Physiology, 1831-1999"; E-A-R 82-6/HP, E.H. Berger, M.S., January 25, 1999
4. "The Noise Manual", 5th Edition, The American Industrial Hygiene Association, May 2000

KEYWORDS: Active Noise Reduction (ANR); Active Hearing Protection; ANR Earplugs; Speech Intelligibility; Improved Communications, Helmet Integrated Communication Systems

N01-163 TITLE: <u>High-Voltage Cables and Connector</u>

TECHNOLOGY AREAS: Materials/Processes, Electronics

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT II: PEO-T, Tactical Aircraft Programs

OBJECTIVE: Develop a compact high-voltage cable and connectors rated to 8 kV capable of withstanding extreme environments experienced in airborne and shipboard military and commercial applications. The effort is specifically focused on solving the high failure rate of present cable/connectors experienced by the Integrated Defense Electronics Countermeasures (IDECM) ALE-55 Fiber Optic Towed Decoy (FOTD) program aboard the F/A-18E/F aircraft.

DESCRIPTION: Develop a high-voltage cable and connector capable of conducting 8 kV of electrical power to the decoy. The proposed cable should be lightweight and not use more volume than the current towline. The towline must withstand the gravitational force place on it by the maneuvering of the aircraft and able to survive the high temperature created by the engine exhaust. The towline must not be susceptible to radio frequency energy coupling which can cause the decoy to function incorrectly. The cable and connectors must be capable of maintaining high signal integrity (i.e. minimal electrical signal transmission loss) over the useful life cycle of the ALE-55 system while requiring minimal maintenance support. The cable/connector system's airborne operating environmental requirements include a high number of maintenance cycles, extreme hot and cold temperatures at high altitude with intense vibration levels and harsh contaminates. The proposed cable must be able to be extended (deployed) at sub- and supersonic speeds.

PHASE I: Perform a feasibility study to re-establish the design criteria for a cable which will provide a high mean time between failure (MTBF) while operating under extreme conditions. Recommend a solution that encompasses the critical material and design criteria. Recommend an innovative design that outlines the connector/cable material and structural design requirements. Provide a design concept that is capable of being demonstrated in Phase II, and that provides the performance necessary to be considered for application into the ALE-55 FOTD program as a solution to current connector/cable performance shortfalls.

PHASE II: Assemble and test a connector/cable engineering design model in order to demonstrate the system's ability to meet above stated performance requirements (i.e. details of which will be fully developed as part of Phase I). Expand the connector/cable design to include F/A-18E/F ALE-55 FOTD temperature/vibration/pressure environmental requirements.

PHASE III: Develop a prototype and demonstrate the connector's ability to satisfy the requirement established in Phase II. Solicit government/commercial agencies and users to invest in developing a prototype that will be compliant with ALE-55 FOTD System as a precursor to government funded flight tests.

COMMERCIAL POTENTIAL: Commercial miniature high-voltage cable and connectors for use in limited space environments.

REFERENCES:

1. http://www.raytheon.com/es/esproducts/ses050/ses050.htm
2. http://www.dote.osd.mil/reports/FY96/96IDECM.html
3. http://www.janes.com/defence/market_review/jrew_2000_2001/radar_and_electronic_warfare_2000-2001_06.shtml
4. http://www.fas.org/man/dod-101/sys/ac/equip/an-ale-50.htm
5. http://www.airforce-technology.com/projects/fa18/

KEYWORDS: High Voltage; Connectors; Miniature Towline Cable; ALE-55; FOTD; IDECM

N01-164 TITLE: Fiber Optic Cables and Connectors

TECHNOLOGY AREAS: Materials/Processes, Electronics

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT IC: PEO-T, Tactical Aircraft Programs

OBJECTIVE: Develop a compact, high durability, fiber optic cable capable of withstanding extreme environments of airborne and shipboard military and commercial applications. The effort is specifically focused on solving the high failure rate of present cable/connectors experienced by the Integrated Defense Electronics Countermeasures (IDECM) ALE-55 Fiber Optic Towed Decoy (FOTD) program aboard the F/A-18E/F aircraft.

DESCRIPTION: The fiber optic cable and connectors must be capable of operating within the harsh operational environment of the ALE-55 FOTD system as installed on the F/A-18E/F aircraft. The cable will be used to provide communications with the decoy and transmit laser energy to the decoy to provide jamming information. The cable and connectors must be capable of maintaining high signal integrity (i.e., minimal electrical signal transmission loss) over the useful life cycle of the ALE-55 system while requiring minimal maintenance support. The cable should be strong enough to withstand the gravitational forces placed on it by the movement of the aircraft and able to withstand high temperatures from the engine exhaust without premature degradation and failure. The cable/connector system's airborne operating environmental requirements include a high number of maintenance cycles, extreme hot and cold temperatures at high altitude with intense vibration levels and harsh contaminates. This cable must be able to be extended (deployed) at sub- and supersonic speeds and be lightweight.

PHASE I: Perform a feasibility study to re-establish the design criteria for a cable which will provide a high mean time between failure (MTBF) while operating under extreme conditions. Recommend a solution that encompasses the critical material and design criteria. Recommend an innovative design that outlines the connector/cable material and structural design requirements. Provide a design concept that is capable of being demonstrated in Phase II, and that provides the performance necessary to be considered for application into the ALE-55 FOTD program as a solution to current connector/cable performance shortfalls.

PHASE II: Assemble and test a connector/cable engineering design model in order to demonstrate the system's ability to meet above stated performance requirements (i.e. details of which will be fully developed as part of Phase I). Expand the connector/cable design to include F/A-18E/F ALE-55 FOTD temperature/vibration/pressure environmental requirements.

PHASE III: Develop a prototype and demonstrate the connector's ability to satisfy the requirement established in Phase II. Solicit government/commercial agencies and users to invest in developing a prototype that will be compliant with ALE-55 FOTD System as a precursor to government funded flight tests.

COMMERCIAL POTENTIAL: Commercial fiber optic cable and connectors for use in limited space environments.

REFERENCES:

1. http://www.raytheon.com/es/esproducts/ses050/ses050.htm
2. http://www.dote.osd.mil/reports/FY96/96IDECM.html
3. http://www.janes.com/defence/market_review/jrew_2000_2001/radar_and_electronic_warfare_2000-2001_06.shtml
4. http://www.fas.org/man/dod-101/sys/ac/equip/an-ale-50.htm
5. http://www.airforce-technology.com/projects/fa18/

KEYWORDS: Fiber Optic; ALE-55; Cable; Decoy; Integrated Defense Electronics Countermeasures (IDECM)

N01-165 TITLE: Corrosion/Erosion Resistant Coatings for Turbine Compression Systems

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: PEO-A, (Air, ASW, Assault & Special Mission)

OBJECTIVE: Develop a corrosion/erosion resistance coating that can be applied to gas turbine compression systems that operate in a naval environment (salt air, steam sand, and dust ingestion) that will increase engine durability and maintain operational engine performance.

DESCRIPTION: Engine erosion and corrosion of compressor blades and vanes has been a critical degrader to the health of the gas turbine engine fleet for naval applications. During Desert Storm, the H-53 helicopters were near grounding due to severe compressor erosion in sand environments. The H-46 engine fleet has to redesign the material system of the compressor systems due to corrosion of the airfoils. Several other engine families also exhibit this compressor airfoil problem. This translates to a high compressor airfoil scrap rate (about $2M per year for the H-53), more frequent engine overhauls, and an appreciable engine performance reduction with operational time. The Department of Defense-sponsored Foreign Comparative Test Program is completing a two-year effort in which an advanced titanium nitride coating was investigated for application to the U.S. military fleet. As a result of the program, 70 percent of the more conventional compressor material stages will be coated in the H-53 fleet. Several other engines are also investigating the coating for application to their compressor airfoils. Additional research needs to be done on applying these coatings to new and advanced base material systems under development and advanced engine configurations such as integral bladed disks (blisks).

PHASE I: Assess the feasibility and practicality of corrosion/erosion resistant coating systems for advanced compressor material systems and configurations with little degradation to the material system. Define application techniques and characterize the coating system's composition and performance on advanced material systems and compressor blisk configurations. Identify coating(s) and coating process(es) for development in Phase II.

PHASE II: Develop coating(s) and coating process(es). Apply the coatings to test coupons and conduct sand erosion and salt water corrosion tests to validate the coating's performance in a naval environment. Conduct blade fatigue tests to determine the high cycle fatigue (HCF) capability of a coated blade/vane sets. Compare results against other know coating systems. Coat the accelerated simulated mission endurance test (ASMET) compressor section and test the coatings system performance in an integrated engine. (The government will provide the compressor hardware for coating and the ASMET engine for the test.) Identify the coating and coating process for final development in Phase III.

PHASE III: Finalize the coating and coating process. Coat a compressor section of a "Lead the Fleet" aircraft for operational field-testing.

COMMERCIAL POTENTIAL: Aircraft gas turbine technology is vital to the U.S. industrial base. Aircraft gas turbine technology is generally applicable to both military and civilian engines. There is application potential of coatings to a broad range of air, ship, and automotive vehicles.

KEYWORDS: Propulsion; Gas Turbines; Aircraft Engines; Materials; Compressors; Protective Erosion/Corrosion Resistant Coatings

N01-166 TITLE: Multi-Channel Electronic Scanning Module for an Ultrahigh Frequency (UHF) Circular Array

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT IC: PEO-T

OBJECTIVE: Develop a modular unit capable of exciting a circular 50- to 60-element UHF electronically scanned array. The unit must maximize the power available from a 50- to 60-channel transmitter and provide a taper across an arbitrary set of adjacent elements (nominally one-half of the array).

DESCRIPTION: The UHF electronically scanned array (UESA) was designed to significantly enhance the capabilities of the Navy’s airborne radar platformthe E2-C. UESA is a non-rotating circular array of 50 to 60 end-fire elements designed to provide unprecedented beam agility. Electronic scanning is implemented by dynamically routing the excitation from a 50- to 60-channel transmitter to a subset of adjacent elements consisting of one-half of the array. On a pulse-to-pulse basis, the desired scanning module will enable UESA to form a beam along any azimuth, regardless of prior beam position. In addition, the scanning module must be able to taper the excitation while utilizing the maximum available power from the 10-kW/channel transmitter. The dynamic range of excitation should be in excess of 20 dB. Designs that show the greatest potential for size and weight reduction will be favored.

PHASE I: Provide a design concept, including theoretical performance specifications, which would be prototyped and demonstrated during Phase II. Electrical specifications should include Voltage Standing Wave Radio (VSWR), insertion loss, power handling, switching time, switching ratio/isolation, and excitation dynamic range. Thermal specifications should include cooling requirements and mechanical specifications should at least include projected size and weight.

PHASE II: Finalize the design and fabricate a functional subset of the 50- to 60-channel electronic scanning module to demonstrate the performance of the proposed system. Performance tests addressing the specifications reported in Phase I should be conducted.

PHASE III: Develop ways to decrease manufacturing costs. Fabricate and deliver up to 40 sets of the scanning module. Consider the scanning module for lower power and higher frequency civilian and military communications systems using circular arrays.

COMMERCIAL POTENTIAL: Aircraft prime contractors for Naval and Air Force airborne radar platforms, foreign military, wireless networking industry, cellular base stations, and any solution provider of secure/non-secure communications that require jamming immunity, low probability of interception, or dynamic beam agility and management.

REFERENCES:
1. M. Zatman, B. Freburger, D. Rabideau, “Circular Array STAP,” 7th Annual ASAP ’99 Workshop, March 10th, 1999. http://www.ll.mit.edu/asap/asap_99/abstract/7.html
2. J. M. Stamm, M. W. Jacobs, and J. K. Breakall, "Comparison of Calculations and Measurements of an Electronically Scanned Circular Array", 16th Annual Review of Progress in Applied Computational Electromagnetics, Naval Postgraduate School, Monterey, CA, 2000.

KEYWORDS: E2-C; Radar; Circular Array; UHF Electronically Scanned Array (UESA); Electronic Scanning, Sensors

N01-167 TITLE: Fuel Reformulation to Reduce Contaminants

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: Joint Strike Fighter (JSF)

OBJECTIVE: Develop a cleaner fuel so that high performance engines can run cleaner and criteria pollutants in the emissions, regulated by the Clean Air Act, will be reduced.

DESCRIPTION: Many of the naval bases proposed to accept deployment of the Joint Strike Fighter (JSF) are in non-attainment of the National Ambient Air Quality Standard (NAAQS) for the emissions of ozone precursors: oxides of nitrogen (NOx) and reactive volatile organic compounds (VOCs). The emissions of particulate matter are also of concern since a number of the naval bases are in areas that are classified as in non-attainment for PM10 (particulate matter of 10 microns or less). Gas turbine engines and ground support equipment are a major source of particulates and soot. The United States military consumes between 4 and 5 billion gallons of hydrocarbon based jet fuel per year. Particulate emissions and soot lead to increased engine and fuel system components maintenance cost, decreased engine life, and decreased aircraft/engine availability.

PHASE I: Investigate ways of reducing contaminants in JP-8 and JP-5 fuels by developing cleaner refining processes, developing more efficient filters, or reformulating the fuel.

PHASE II: Provide details of process/es that reduce emissions most successfully. Determine emission reduction for each potential technology.

PHASE III: The emission reduction equipment or fuel reformulation, upon meeting JSF program requirements, will be transitioned to the Preliminary Weapon System Concept (PWSC) and JSF community for potential use. The maintenance procedures and instructions will be updated accordingly.

COMMERCIAL POTENTIAL: Engine emissions are a problem both in the private sector and DoD. The commercial sector is even more heavily regulated than the DoD. A successful reformulation of fuel, or the use of equipment to reduce emissions, could be used by a large portion of the military systems with the potential for use in commercial aircraft as well.

REFERENCES:
1. MIL-DTL-5624, TURBINE FUEL, AVIATION, GRADES JP-4, JP-5, AND JP-5/JP-8 ST dated 18 Sep 1998

KEYWORDS: Fuel; JP-8; JP-5; Emissions; Reformulation; Aircraft Engine

N01-168 TITLE: <u>Thin Layered Damping Treatments for Turbo Machinery</u>

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: Joint Strike Fighter (JSF)

OBJECTIVE: Develop a process to apply a thin layered material on the order of 0.001” or less to blading of gas turbine engines in order to reduce vibrations of these components.

DESCRIPTION: State-of-the-art designs of compressor and turbine rotors for aircraft gas turbine engines, are using integrally bladed rotor technologies (rotor and blades are one piece – continuous structure). The advantage of this one-piece construction is weight savings and reduced losses from cavity flows inherent with a bladed disk (inserted blades). The disadvantage comes from the reduction of overall damping provided by the friction interface at the blade/disk attachment. Therefore, the integrally bladed rotor has less damping and is more susceptible to fatigue failures. One approach to reduce fatigue failures is constrained layer damping with viscoelastic materials. In the past, these constraining layers were on the order of 0.030” thick. However, new manufacturing and deposition processes create the possibility of constraining layers on the order of 0.001” thick with the viscoelastic materials on the order of micro-inches. This SBIR will pursue manufacturing and deposition process technologies; such as cold rolling of titanium and plasma deposition of viscoelastic material, to achieve constraining layer damping treatments for integrally bladed rotors on the order of 0.001” thick.

PHASE I: Assess the applicability, feasibility and practicality of thin layered materials (on the order of 0.001”thick) for damping integrally bladed rotors. Identify manufacturing processes capable of applying thin constraining layers of titanium and nickel based alloys for the integrally bladed rotor application. Identify deposition processes capable of applying thin layers of viscoelastic materials for the integrally bladed rotor application. Identify material(s) and process(es) for development in Phase II.

PHASE II: Develop the damping material and the manufacturing/deposition process. Demonstrate the ability to apply a thin layer of damping material on beam and blade test specimens (substrate (rotor material) with similar geometry). Apply a thin layer to an integrally bladed rotor and conduct static and spin tests to determine damping effects, wear characteristics and life of the thin layer, and any chemical/physical interaction between the rotor substrate and thin layer material. Finalize Phase III application process and material development requirements. (Notes: (1) At the end of Phase I, the number of test specimens and rotors to be provided for Phase II will be identified. (2) The Navy will provide spin test facilities.)

PHASE III: Complete process development. Apply thin layer material to an integrally bladed turbine rotor. Conduct full-scale demonstration in a gas turbine engine. (The Navy will provide the turbine rotor and coordinate the test with the engine manufacturer.)

COMMERCIAL POTENTIAL: Thin layered damping treatments are sought after in all fields of turbo machinery. This includes commercial aviation in which aerodynamics of surface conditions are important as is the thickness of the damping treatment so as to not detrimentally effect the engine’s efficiency.

REFERENCES:
1. Ross, D., E. Ungar, and E. M. Kerwin, "Damping of Plate Flexural Vibrations by Means of Viscoelastic Laminates", Proc. Structural Damping ASME, pp. 49-87, 1959
2. Jones, D., "Materials for Vibration Control in Engineering", Shock and Vibration Bulletin, 43, pp. 145-151, 1973.

KEYWORDS: Integrated Bladed Rotor; Rotor Damping; Deposition Process; Viscoelastic Materials; Turbo Machinery; High Temperature Alloys

N01-169 TITLE: Non-Mechanical Beam Steering for Infrared Countermeasure (IRCM) Applications

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT II: PEO-T

OBJECTIVE: Develop a compact scanner that can redirect light (laser or IR image) by non-mechanical means.

DESCRIPTION: The Naval Aviation Systems Team is developing a number of IRCM systems that use lasers to protect aircraft from IR guided threats. Current systems steer the laser energy by mechanically driven mirrors. These mirrors are prone to failure in the extreme vibration environments of a tactical aircraft. They also take up a large fraction of the size and weight allocated for the system. What is needed is a compact/non-mechanical method of redirecting the laser energy, which would simplify and improve the IRCM system. Concepts proposed must support the functions of the tactical directed (DIRCM) concept including a mid-wave infrared receiver/tracker and an open-loop IRCM laser transmitter/beam-director. Concepts must be able to transmit and receive midwave infrared (MWIR) signals over an angular coverage of at least 90 degrees with a one milli-radian degree resolution. Concepts must be able to cover the wavelength range of 1.0 to at least 5 microns, and handle at least 5 watts of laser energy without damage. The system should be able to redirect the laser energy at a rate of at least 5k radians/sec. The goal of this SBIR topic is to develop an IRCM concept that is practical, affordable and compact enough to fit into existing IRCM jamming systems. Proposals will be ranked on complexity, cost and practicality.

PHASE I: Perform a concept design and feasibility study that will address the following areas: a) optical transmission over the entire mid-IR band; b) speed or bandwidth for tracking; c) size, weight, power, and cost estimates; and d) aperture and wave front error.

PHASE II: Build a prototype and perform the requisite analyses for future integration in to an existing CM system. The system will be tested in the laboratory and ground tested at long-range to demonstrate acceptable performance.

PHASE III: Upon successful completion of the Phase II effort, the system will transition to PMA-272 for integration into a defensive system being developed for tactical fixed and rotary wing aircraft.

COMMERCIAL POTENTIAL: This technology could be used in a laser based remote sensing application: for example, pollution monitoring, oil pipeline leaking detection and in areas where one is trying to detect molecules from a distance. This system could be used for surveillance applications such as non-cooperative air or ground identification for both military and the law enforcement community.

REFERENCES:
1. “TADIRCM Live Fire Test Results,” 00 Military Sensing Symposia (MSS) April 00, 9-11 Naval Post-Graduate School, Monterey CA.
2. “Live Fire Testing of WANDA™/VIPER™/MIMS/NEMESIS DIRCM,” 00 Military Sensing Symposia (MSS) April 00, 9-11 Naval Post-Graduate School, Monterey CA.

KEYWORDS: Infrared; Infrared Countermeasure; Laser; Tactical Aircraft; Jammer; Directed IR Countermeasures

N01-170 TITLE: New Cooling Technology to Increase Aircraft Generators Power Rating

TECHNOLOGY AREAS: Air Platform

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT II & IC: PEO-A

TITLE: New Cooling Technology to Increase Aircraft Generator Power Rating

OBJECTIVE: Develop and incorporate new and innovative thermal design techniques into existing generator packages. The goal is to significantly increase generator power output on a continual basis without changing the generator size, weight, or other operational parameters.

DESCRIPTION: Navy aircraft are experiencing avionics growth and operational life extensions requiring increased generator power output without affecting the other aircraft systems or structures. Adding a bigger generator is not a solution because it will have a significant affect on engine and accessory gearbox design and other aircraft systems. Present generators are designed with significant overload capacity inherent to the electromagnetic design. They are limited from providing this additional power on a continual basis due to thermal constraints. New cooling technologies that will increase the generator power output without effecting other aircraft systems are vital to maintaining aging aircraft.

The successful candidate shall demonstrate in the proposal their familiarity with aerospace generator design including the basic understanding of rotational dynamics and electromagnetic design.

An initial generator type will be selected to evaluate the novel cooling technology. A 60 KVA, constant speed, air-cooled generator (used in the P-3, E-2C, C-130, and other Navy aircraft) will be a logical, initial application of novel cooling techniques because of its simple design and a known need for additional electrical power by platforms utilizing this generator type. Proposals are not, however, limited to a specific generator type. Evaluation of other generator types under this effort are encouraged and ultimately all technologies developed under this effort will be applied to a wide variety of machines used in both military and commercial applications.

One possible approach to achieving the program objectives is the incorporation of innovative cooling materials. The Naval Research Laboratory (NRL) is developing a new cooling technology for high power static magnetic elements to increase power output without increasing the magnetic element size. This technology has not been evaluated for use in a dynamic (i.e. rotating) environment. While it is believed that this technique may greatly enhance the thermal efficiency of existing designs and configurations, a variety of cooling techniques are sought.

PHASE I: Define a generator cooling approach and develop an initial design and implementation plan for the selected generator type. Validate the approach analytically or provide test data or bench top hardware that validates the approach. Selected candidates should make maximum use of computer modeling and simulation techniques. The goal is to increase the generator power by 30 to 50%.

PHASE II: Using the selected generator type, develop and demonstrate the generator cooling technology without changing the generator size, weight, or other operational parameters. The generator, which can either be a reworked existing machine or other such suitable prototype, is to be subjected to “proof of concept” testing to verify the increase in generator power rating over full operational ambient conditions. For example, a generator type presently rated for 60/90 kVA will have a minimum rating of 80/90 kVA and, possibly, 90/120 kVA after incorporation of the new cooling technology.

PHASE III: Package and integrate the new generator cooling technology for use in an aircraft generating system. The unit(s) should be subjected to full qualification testing and flight-test profiles.

COMMERCIAL POTENTIAL: The novel cooling technology developed under this effort will have widespread application in commercial electromagnetic devices such as generators and transformers. This technology will provide a substantial increase in power density for electromagnetic devices that will result in smaller size and weight or increased power capacity. Commercial airlines are specifically interested in increasing the power density of electromagnetic devices utilized in generation, distribution, and avionics components. The results of this effort will be equally beneficial to consumer products and industrial applications because of improvements in thermal efficiency and reliability.

REFERENCES:
1. Eddie Sines, “ Electric Power Cooling Technique,” Navy Patent Pending Case Number 79955, 1999.

KEYWORDS: Generator; Cooling; Power Density; Avionics; Electrical Power; Magnetics

N01-171 TITLE: <u>Visualization and Quantification System for Modeling Unsteady Aerodynamics for Aircraft Simulations</u>

TECHNOLOGY AREAS: Air Platform

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT IC: PEO-T

TITLE: Quantitative Flow Visualization/Measurement System for Modeling Unsteady Aerodynamics in a Water/Wind Tunnel

OBJECTIVE: Develop a methodology, hardware and/or instrumentation to simultaneous visualize and measure unsteady flow phenomena in a water and/or wind tunnel. The proposed method should measure forces and moments and concurrently obtain quantitative flow visualization data of unsteady aircraft behavior during water/wind tunnel testing. The quantitative flow visualization will be used to corroborate traditional force and moment measurements and aid in creating physically representative aerodynamic models based on those measurements.

DESCRIPTION: Current aircraft aerodynamic models, as used in simulation and in control law development, are weak in the area of unsteady aerodynamics. This is due to the high cost associated in acquiring high fidelity data or difficulty in understanding the correlation between lower fidelity force and moment measurements and the associated unsteady flow phenomenon. Develop and demonstrate a water/wind tunnel test technique that measures aerodynamic forces and moments (through use of balance, pressure taps, or other technique) while concurrently conducting quantitative flow field visualization during unsteady flow conditions. The quantitative flow field visualization will be used to corroborate force and moment measurements and capture off-body flow characteristics for use in generating accurate unsteady regime aerodynamic models. Such models could then be incorporated into existing simulation databases for use in supporting engineering simulations and fleet trainers, reducing engineering efforts and flight test costs as well as improving pilot training fidelity.

PHASE I: Determine the feasibility of using a novel methodology, hardware and or instrumentation that will tie together quantitative visualization techniques with traditional force and moment measurements. The concept should incorporate data from the tunnel, balances, flow visualization equipment, and data acquisition equipment. Develop a test matrix to exercise the system (e.g., sweeps, flow conditions, etc.). The final report should explain how the force/moment and flow visualization data would be used to model the unsteady aerodynamics. This will be used in Phase II to develop higher fidelity mathematical models than are currently in existence in unsteady flow regimes.

PHASE II: Develop a prototype and demonstrate it using a Navy military aircraft model. Use the results (tying together force and moment data with flow visualization data) to formulate mathematical models that are able to accurately predict aircraft response in unsteady flight regimes. Demonstration success will be based on a comparison, in a PC based simulation, of the model developed under this SBIR and an existing model.

PHASE III: Transition the demonstrated technique to aircraft programs for use during design, development, developmental testing and follow-on efforts.

COMMERCIAL POTENTIAL: The correlation of real-time quantitative flow visualization integrated with aerodynamic force and moment measurements during unsteady conditions is an undeveloped capability which could benefit both military and commercial applications. In addition, this technique will potentially aid in the understanding of unsteady phenomenon during traditional static and dynamic testing. Private sector transitions could include design tools for commercial aircraft.

KEYWORDS: Unsteady Aerodynamics; Quantitative Flow Visualization; Aerodynamic Coefficients; Modeling; Dynamic Testing; Vortex flows

N01-172 TITLE: New Mid-Infrared (IR) Laser Materials

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT II: PEO-T

OBJECTIVE: Develop growth and fabrication for rare earth doped chloride laser crystals.

DESCRIPTION: Conventional near-IR solid-state lasers work so well because trivalent rare earth ions can store energy in their electronic configurations for hundreds of microseconds. This allows time for low intensity optical pumping to high levels of excitation and gain. Low concentration neodymium doped oxides, for example, can store the energy for about 200 µs. They produce excellent 1.06-µm lasers when pumped at 0.8µm. Similarly erbium, thulium, and holmium ions yield very useful laser transitions at 1.5, 2.0 and 2.1 µm. However, for rare earth transition wavelengths longer than 3 µm, the storage lifetime falls very rapidly to the nanosecond time-scale. Pumping such short-lived states requires very high intensities, which preclude simple compact lasers.

The process that causes shortened lifetimes at longer wavelengths is called multi-phonon quenching. In this process, excited electronic states decay via the creation of several quantized vibrations in the inter-atomic bonds. This non-radiative decay route deactivates the optically pumped state. Multi-phonon quenching occurs in all solids, but its strength depends exponentially on the energy of the highest frequency optical phonons for each solid. Solids composed of lighter elements have higher phonon energies and exhibit much higher multi-phonon quenching rates. Since all conventional rare earth lasers are based on oxides and fluorides, with phonon energies in the 700 to 400 cm-1 range, they are subject to strong multi-phonon quenching for transitions longer than 3 µm. This is why direct solid-state lasers are not available in the mid-IR.

Recent work has shown that low phonon host materials can enable rare earth lasers. Based on chloride crystals, these materials have maximum phonon energies in the range of 200 – 250 cm-1. Rare earths doped into these crystals exhibit excellent energy storage lifetimes (milliseconds) for transitions out to at least 8 µm. Using these materials, direct mid-IR lasers have been demonstrated without the need for cooling below ambient temperatures. The most promising of these low phonon laser crystals is KPb2C15. This biaxial crystal is sufficiently hard and stable to enable practical laser sources. This crystal can be grown via vertical Bridgeman techniques and doped with rare earths to at least the 2E20 ion/cc. Crystallization occurs in a melt at 435 °C under a dilute chlorine atmosphere

PHASE I: Conduct experimental growth of KPb2C15 crystals doped with the rare earth erbium. Spectroscopic samples would be evaluated at the Naval Research Laboratory.

PHASE II: Refine growth techniques for the production of clear, oriented crystals of several centimeters in length. Samples would be tested for laser performance at the Naval Research Laboratory.

PHASE III: Improve facilities for production of mid-IR laser crystals for use in DOD laser systems.

COMMERCIAL POTENTIAL: Laser sources in the mid-IR have commercial applications in chemical detection, thermal imagery and surgical systems.

REFERENCES:

1. S. R. Bowman, S. K. Searles, N.W. Jenkings, S. B. Qadri, E. F. Skelton and Joseph Ganem, “Diode pumped room temperature 4.6 µm erbium laser,: Topical Meeting on Advanced Solid-State Lasers, Seattle WA, Jan 2001.
2. S. R. Bowman, L. B. Shaw, B. J. Feldman and Joseph Ganem, “A 7 micron praseodymium based solid-state laser,” IEEE J. Quantum Electron. 32, pp.646-649 (1996).
3. S. R. Bowman, S. K. Searles, Joseph Ganem and Paul Schmidt, “Further investigations of potential 4 µm laser materials” Trends in Optics and Photonics Vol XIX: Advanced Solid-state Lasers, Hagop Injeyan and Martin M. Feger, ed., (Optical Society of America, Washington DC 1999), pp. 487-490.
4. K. Nitsch, M. Dusek, M. Nikl and M. Rodova, Prog. Crystal Growth and Charact. 30, 1-22, (1955).

KEYWORDS: Mid-Infrared Lasers; Rare Earth Lasers; Ternary Chloride Crystals; Compact Lasers; Crystal Growth; Countermeasures

N01-173 TITLE: <u>Non-Explosive Broadband Acoustic Source for Multi-Static Anti-Submarine Warfare (ASW)</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT IC: PEO-A

OBJECTIVE: Develop a non-explosive command activated broadband acoustic source for multi-static ASW. This source will meet the performance of the existing source, while significantly improving safety with lower cost.

DESCRIPTION: Current sonobuoy broadband sources utilize explosive material to produce a broadband ping. Use of this material requires that part of the sonobuoy be assembled by a qualified explosive manufacturer. The final assembly of the sonobuoy therefore occurs outside the sonobuoy manufacturer’s plant. To insure the safety of personnel, strict procedures are instituted for the manufacturing, handling, shipping, and storage of the final sonobuoy assembly. This adds significantly to the life-cycle cost.

This broadband acoustic source concept exploits the advantages of the aluminum-water reaction, specifically its energy efficiency and safety aspects. The aluminum-water reaction is a highly efficient source of energy for two reasons: aluminum-water is nearly four times as energetic per gram as trinitrotoluene (TNT) and seawater provides the oxidizer. Aluminum powder, the primary fuel, is inert until it is combined with water and raised to over 900 degrees Celsius. Consequently, an acoustic source sonobuoy using this technology would require little or no special handling or storage. Technology to reliably control the aluminum-water explosion with a specific pulse length, intensity, and radiation pattern needs to be developed.

PHASE I: Determine the effects of aluminum-water source configurations, aluminum powder grain size, heat rate, water intrusion rate, housing size and charge shape on acoustic parameters in terms of acoustic source level, spectral output, and beam pattern. Select the aluminum-water concept that best matches the acoustic parameters of the current SSQ-110 sonobuoy explosive source. The SSQ-110 sonobuoy is the Navy's latest state-of-the-art sonobuoy.

PHASE II: Develop the design concept proposed in Phase I. The design should include housings, deployment mechanisms, and the ignition and control systems necessary to deploy and direct a broadband acoustic pulse. Fabricate a prototype acoustic source, conduct an ocean field test, and measure the performance of the system in terms of beam width, source level, and acoustic spectral content. The prototype would consist of a line with aluminum capsule charges distributed vertically in an array 65 feet long and a command and control module for electrical power and explosion initiation. Prior to the test, a safety plan is to be submitted for review and approval. Provide a design concept for the integration of an aluminum-water acoustic source into the existing SSQ-110 sonobuoy configuration including its communication and control systems.

PHASE III: Integrate the aluminum-water source into an SSQ-110 sonobuoy configuration. Conduct full-scale field demonstration of the sonobuoy with an aluminum-water acoustic source. Finalize engineering design and production processes.

COMMERICAL POTENTIAL: This high-energy underwater acoustic source could be used by the oil exploration industry. This technology could find uses in any application requiring highly controllable underwater explosions.

KEYWORDS: Sensors; Impulsive Source; Acoustic Source; Multi-static Anti-Submarine Warfare (ASW); Non-explosive Source; Aluminum Water Reaction

N01-174 TITLE: Wireless Leave-In-Place Aircraft Structural Nondestructive Evaluation (NDE) Sensors

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT IC: PEO-A

OBJECTIVE: Develop leave-in-place, small, lightweight nondestructive sensors that can be interrogated and analyzed via wireless/Internet connection for structural health assessment.

DESCRIPTION: Aircraft structural components are often hidden by overlying panels and airframe skin. Corrosion and fatigue damage can go unnoticed until the damage is severe. To avoid the high cost of inspections, there is a need to assess the structural integrity of these components in a noninvasive manner. Often 500 to1500 man-hours are required to inspect structures buried deep within the body of an aircraft. The sensors should be inexpensive since they are mounted permanently in the aircraft and many may be required to fully inspect complex airframe structures. A remote data interrogation capability is important to minimize operational down times associated with NDE inspections. An added benefit of this type of operation is the potential to obtain (near) real-time inspection results while in service. These results would then be communicated to a central point for analysis and historical comparison, and thus assist in preparing aircraft maintenance packages and schedules. The total weight of the system should not exceed 15 pounds, including transmit/receive electronics, for an array of 20 or more sensors. The installed sensor must be reliable. The sensor's life should ideally span that of the aircraft.

PHASE I: Assess the feasibility and practicality of sensors, electronics, and wireless communication systems for use in an aircraft environment to monitor structural health of an aircraft. Prepare a design for a wireless operation/inspection system to be developed in Phase II.

PHASE II: Develop sensors, electronics, and wireless communication systems for aircraft structural components and demonstrate on a breadboard level. The prototype system should include at least 20 leave-in-place sensors with remote data interrogation capability and Internet data communications. Finalize the design of the structural health monitoring system for Phase III.

PHASE III: Conduct a full-scale demonstration in an aircraft. Refine production processes for sensor and communication system.

COMMERCIAL POTENTIAL: Structural integrity in aircraft is a major concern in all flight operations. There is a potentially large market in many industries for a system that is unobtrusive and reliable in operation, low in cost, and does not require expert operators or on-site expertise to interpret the results. In addition to aircraft there are hidden structural members in almost any large industrial plant, including ships, trains, power plants, and any manufacturing operation. The ability to economically inspect and assess structural integrity with no on-site equipment other than a wireless transceiver can affect long term cost savings and reliability improvement – a highly marketable commodity.

REFERENCES:
1. Proceedings of the First, Second, Third and Fourth International Aircraft Corrosion Workshops.

2. Rose, J.L., Soley, L., "Ultrasonic guided waves for the detection of anomalies in aircraft components", Materials Evaluation, Vol. 50, No. 9, Pgs. 1080-1086, September 2000.
3. Rose, J.L., Hay, Thom, "Portable PC based ultrasonic guided waves inspection of an SH60 helicopter transmission beam", Fourth International Aircraft Corrosion Workshop, August 22-25, 2000, Patuxent River, MD.

KEYWORDS: In-Situ Sensors; Remote Operating; Fatigue Cracks; Structural Damage; Corrosion; Aircraft System

N01-175 TITLE: CODEC (Code/Decode) for Digital Buoys in a Harsh RF Environment

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT II: PEO-A

OBJECTIVE: Develop Code/Decode scheme to improve the quality, integrity, and performance of data transmission between an ADAR sonobuoy and the tracking aircraft.

DESCRIPTION: The Air Deployable Active Receiver (ADAR) sonobuoy is an underwater array of hydrophones that is used for Antisubmarine Warfare. Electrical impulses from the array are beamformed and then modulated onto an analog RF uplink. The data are sent up in digital format on the uplink. The data are then received on the aircraft by an AN/ARR-78 receiver.

A simulated study recently conducted (Mitre, 3/2000) demonstrated that significant channel interference and fallout occur when interferors occur within the uplink transmission band. The study demonstrated the point at which the bit error rate (BER) exceeded spec and the point at which the receiver lost synchronization.

CODEC is envisioned as using coding/decoding of transmitted data, whether through redundancy, encryption, compression or error correction to address the RFI (Radio Frequency Interference) problem. Because of the sensitivity of the numbers in the Mitre study any contractors responding with a proposal should assume a constant BER specification exceedance number and a constant sync loss number. The emphasis in judging the proposals will be on how an RF carrier with digital information can be protected from interference over long ranges (50 nm) in the presence of interfering noise.

PHASE I: Assess coding/decoding schemes that improve transmission quality for digital data on an analog carrier where the digital data transmission bandwidth is on the order of 10 kHz. Document the feasibility, practicality and risks associated with each coding/decoding scheme. Identify coding/decoding technologies and a scheme for development in Phase II.

PHASE II: Develop the scheme(s) recommended in Phase I. Assemble breadboard transmission and receiver units and install coding/decoding scheme. Demonstrate improved transmission through simulation testing. Identify a design concept for Phase III implementation of the code/decode scheme in the ADAR system

PHASE III: Complete the design. Conduct full-scale demonstration in ADAR sonobuoy system.

COMMERCIAL POTENTIAL: Any system having wireless transmission could benefit from the technology developed under this topic, e.g., other digital sonobuoys, digital cellular phones, satellite transmission, etc.

REFERENCES:
1. Hamming, R. W., "Coding and Information Theory," Prentice-Hall, 1980
2. Richards, R. K., "Digital Design," Wiley-Interscience, 1971
3. Waggener, William N., Pulse Code Modulation Systems Design, Artech House Inc., 1999.

KEYWORDS: Code/Decode; Channel; Transmission; Redundancy; Packets; Source; Receiver; Reconstruction

N01-176 TITLE: Fiber Optic Ethernet for Aviation Intercommunications System Voice Transmission

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT II, IC: PEO-A

OBJECTIVE: Provide architecture options and feasibility for use of fiber-optic Ethernet protocols for aviation intercommunications systems.

DESCRIPTION: The use of fiber optic technology provides a secure and low-noise physical layer in data buses. Ethernet provides open architecture data bus protocols. However, fiber optic Ethernet protocols use star topologies, which allow a single point of failure at the hub. Thus, it is not desirable in aircraft digital Intercommunication System (ICS) installations. If the star topology could be modified to provide multi-drop architecture, or if some other means could be devised to mitigate the problems inherent in a star architecture, while still maintaining the advantages of the Ethernet protocols for ICS use, the fiber optic network would become much more attractive.

PHASE I: Provide a feasibility study that addresses the problems of fiber optic Ethernet protocols and their applicability in aircraft ICS applications, addressing specifically the problems with a center hub/star architecture. Also, address specifically the problems with center hub/star architecture. Also, address specifically the transmission of real-time voice over Ethernet and the requirement to run dual redundant buses as a backup measure. Provide a report detailing the findings of the Phase I study.

PHASE II: Provide a working prototype of the architecture selected by the government from the Phase I results.

PHASE III: The transition of this technology will offer ICS options currently available for multi-radio military aviation platforms, offering advantages in weight, power consumption, and security over currently available approaches.

COMMERCIAL POTENTIAL: A fiber optic ethernet could provide a secure, low-noise inter-communication system for commercial aviation applications. This technology could also be applied to reduce factory floor noise in industrial applications.

KEYWORDS: Avionics; Communications; Ethernet; Intercommunications System; Fiber Optics; Data Bus Protocols

N01-177 TITLE: Hydraulic Seal Replacement

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop and implement a replacement long-life seal for use in hydraulic, fuel, and environmental control systems

DESCRIPTION: The military aviation community experiences an alarmingly high rate of premature failures in elastomer seals. Leaking hydraulic seals, in particular, account for over 200 million dollars in annual repair costs, primarily because all hydraulic components rely on hydraulic fluid to lubricate and cool the components when in use. When fluid is lost, these components run dry and seize. Many of the components have caught fire and caused collateral damage to the aircraft and surrounding structure. These failures can almost always be attributed to a leaking seal. The hydraulic fluid itself is also a contaminant that contributes to collateral damage. Further, the fluid used in the environmental control system is very corrosive and has been a factor in damage to electronic components within the aircraft. The seals in question are manufactured from a nitrile base compound that tends to lose its elasticity (harden) at temperatures above 200(input degree symbol)F and below 60 (input degree symbol)F. As a result, leakage occurs that is not always detected in time to prevent primary system or collateral damage. This problem affects all military and commercial aviation. Further, these seals become brittle at very low temperatures and can crack resulting in damage. This initiative seeks to develop a replacement seal compound that eliminates all known limitations in temperature extremes and operating fluids. The analysis must include recommendations for alternative long-life seal material that will both maximize durability to withstand the operational environment conditions of the F-14 aircraft and can be cost-effectively implemented. The operational range of the material must be from -90(input degree symbol)F to 350(input degree symbol)oF for a period of 3 hours. The material must have minimal variations in tensile strength and ultimate elongation over the entire temperature range. The material must demonstrate a resistance to abrasion, tearing, and heat aging at temperatures up to 350 (input degree symbol)F. It shall demonstrate the ability to provide excellent metal adhesion in a wide range of applications.

PHASE I: Demonstrate the feasibility of manufacturing a consistent, high quality elastomeric compound for hydraulic seal applications. The seal material must have an operational range from -90(input degree symbol)F to 350(input degree symbol)F for a period of 3 hours. The material must have minimal variations in tensile strength and ultimate elongation over the entire temperature range. The material must be resistant to abrasion, tearing, and heat aging at temperatures up to 350(input degree symbol)F. It should provide excellent metal adhesion in a wide range of applications. Existing seal specifications, which must be modified to incorporate the new compound/technology, will be identified under Phase I.

PHASE II: The results of this phase are a detailed process for the fabrication of the high-temperature elastomeric compound, for hydraulic seal applications, and validation of seal characteristics. Samples of the new batch compound recommended during Phase I will be provided to the seal vendor for fabrication into seal for specific applications (hydraulic fluid, JP-4/5/8/NATO, environmental control systems). Validation tests of the seals, on military aircraft specific applications, must be performed in this phase. First article/prototype tests will be conducted on EA-6B rudder, stabilizer, and flapperon actuator assemblies and F-14 spoiler, rudder, and four-way valve actuator assemblies.

PHASE III: The new seal will be implemented as a preferred spare in all appropriate aircraft applications. Implement procurement of new hydraulic seals using the improved seal compound.

COMMERCIAL POTENTIAL: Commercial aircraft suffer from the same inherent problems in their flight control and hydraulic systems. The development of a new, durable, long-life seal can be directly applied to all military and commercial aviation worldwide. The base polymer compound to be developed under this initiative could be applied to a wide range of heavy industrial, military, ship, and space programs. The material envisioned can be used in gaskets, diaphragms, hoses, shock mounts, foams, coatings, and electrical applications. Its demonstrated structural properties make the elastomer a candidate in biomedical applications and devices. The automobile industry is another candidate for use of this material in engine manufacturing. The base compound elastomer can also be used in the fabrication of artificial skin for use in burn victims.

REFERENCES:

1. Reynard, K. A.: Woo, J. T. K.; Rose, S. H. (Horizons, Inc.) "Synthesis of new low temperature petroleum-resistant elastomers," U.S. Govt. Report, 1971, AD734,347
2. Tate, D. P., "Phosphazene Elastomers," J. Polymer Sci., 1974, 48, 33.
3. Singler, R. E., Schneider, N. S.; Hagnauer, G. L. "Polyphosphazenes - Synthesis, Properties, and Applications," Polymer Eng. Sci., 1975, 15, 323.
4. Penton, H. R., "Semi-Inorganic Elastomers for Specialty Applications," Kautschuk u Gummi, 1986, 39, 301.
5. Kolich, C. H.; Klobukar, W. D. "Improving the solvent resistance of PNF elastomer," 1990, US Patent 86383624.
6. Mark, J. E.; Allcock, H. R.; West, R. "Inorganic Polymers," 1992, Ch. 3, Prentice-Hall, Englewood Cliffs, NJ.

KEYWORDS: Elastomer; Nitrile; Seal; Fuel; Environmental Control Systems; Hydraulic Fluid

N01-178 TITLE: Photonic Switching for Aircraft Fiber Optic Networks

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT IC: PEO-T

OBJECTIVE: Develop rugged photonic switching technology for aircraft networks.

DESCRIPTION: A critical component required to implement fail-safe optical interconnects is a high speed switching mechanism. Switching is required for redundancy management in optical networks as well as a data routing mechanism for use in computer architectures. Switching can be done in either the optical or the electronic domain. Today, only electronic switches are being proposed for aerospace platforms due to the low technology readiness level of electro-optic or all optical approaches. The use of wavelength division multiplexing provides for both parallel data transmission with simplified switching complexity. Switching parameters that need to be optimized include throughput, bandwidth, switching speed, power dissipation, packaging density, and fan-out capability. Successful implementation of photonic switching can provide for scaleable networks with built-in fault prediction, isolation, and circumvention by providing in-flight diagnostics and real-time configuration of the cable plant. All optical switching and wavelength division multiplexing provides compatibility with the most commonly proposed network protocol standards and provides the capability to update a platform with higher bandwidth capability and new network protocols as they evolve without the need to replace the switch.

PHASE I: Identify the most promising optical technology to implement both multi-mode and single-mode optical switches for aircraft applications. Complete an analysis of alternative implementations highlighting key performance and environmental properties of the proposed technology and crossbar switch design including hardware and software control mechanisms.

PHASE II: Design, demonstrate, and package a 32 x 32 optical switch compatible with a switched fibrochannel network architecture.

PHASE III: Ruggedize and optimize the optical switch for flight testing in a Navy aircraft.

COMMERCIAL POTENTIAL: All optical switching can apply to optical local area networks as well as industrial control applications.

KEYWORDS: Photonics; Optical Switching; Wavelength Division Multiplexing; Fiber Optic; Networks; Data Transmission

N01-179 TITLE: Low-Cost Dual-Mode (Visible/Infrared) Imager

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT II: PEO-W

OBJECTIVE: Develop and demonstrate low-cost dual-mode imaging sensors

DESCRIPTION: Despite their obvious great military and commercial value, dual-mode visible/infrared imagers have not been constructed historically due to cost and complexity issues. In both military and commercial applications, the need for imaging systems that operate day and night is increasing. Military systems are reverting more and more to autonomous target recognition (ATR) systems to locate targets and guide weapons. Almost all military imagers that perform autonomously have been constructed to operate in the infrared spectral region because infrared provides both daytime and nighttime capability. However, since the majority of target reference imagery is available only in visible spectral bands, ATR algorithms are often stressed to perform their functions with real-time infrared imagery. Many times, during daytime operation, both the visible and the infrared bands can be used in a synergistic manner. For example, a dual-mode seeker would provide a cross-spectrum check on ATR correlations.

Recent progress in the manufacturing of optical components and advances in uncooled detector technologies have made it possible to construct affordable dual-mode imagers with the same if not better performance as current imagers. Camera housings can be constructed of thermoplastics or other moldable materials. Production methods include injection molding or press molding. Optical components, such as lenses, can be made of moldable materials. Dispersion can be corrected for by use of diffractive elements. Uncooled infrared detector arrays give sensitivity and resolution performance previously available only with expensive cooled array systems. For purposes of this solicitation, the imager is defined to output RS-170 and digitized imagery. To retain compatibility with the majority of weapons and weapons-support systems, the cameras should compactly fit within a 10-inch cube, preferably smaller. As a guideline, respondees may consider diffraction limited resolution of 0.25 milliradian and sensitivity of 0.1oC or less to be responsive to military needs. Commercial needs may or may not differ. Electronic zoom and simultaneous display/processing of infrared and visible images are adjuncts that may be considered in response to this solicitation. Reflective or refractive optical designs are acceptable. In order to fulfill the requirement of low cost, the projected production costs for lots of 1,000 units should not exceed approximately $12-$20K. Cost considerations should be addressed in response to this solicitation.

PHASE I: Provide a design concept for an affordable dual-mode imager employing recent technology improvements to reduce cost without degradation to current performance. Include as many of the technologies associated with the dual-mode imager approach as possible, including the anticipated image quality, whether by a laboratory instrument or simulation. Electronic design and development should also be provided in detail, including a description of signal interfaces.

PHASE II: Implement the concepts of Phase I and demonstrate one or more prototype dual-mode imagers. The Phase II demonstration units must exhibit form-fit-function of the anticipated Phase III all-up deliveries. As much as possible, the prototype units should be environmentally tested in a laboratory environment. Full qualification examinations are not required. However, all risk areas must be satisfactorily addressed by test, simulation, similarity, or analysis. Conduct a detailed cost analysis of the technology and its return on investment.

PHASE III: Produce a limited number of production-representative units for delivery to Government and industrial users for testing.

COMMERCIAL POTENTIAL: The dual-mode imager has many potential commercial applications. These include home security systems; business security systems; anti-terrorist applications; and public building security systems such as schools, court houses, etc. In most applications, the visible is used for daytime or artificially lit scenes and the infrared for smoggy or nighttime conditions. Under many daytime conditions, the visible and infrared images can be correlated with each other to maximize the information gathered.

REFERENCES:

1. Balcerak, Raymond S.; “Uncooled IR Imaging: Technology for the Next Generation”, SPIE Proceedings, Vol. 3698, Paper 17, 1999.
2. Radford, W. et. al., “Sensitivity Improvements in Uncooled Microbolometer Arrays”, Proceedings of the IRIS Passive Sensors Specialty Group, Montrey CA, February 1999.
3. VITREX Company Literature, “Properties of PEEK Polymer”, Web Site www.linkupon.com/linkupon/peek.html, December 2000. (See other web sites under “PEEK”)
4. Wyatt, Clair L., “Electro-Optical System Design”, McGraw Hill, Inc., 1991, (See especially Ch 12 and 13)
5. Ronm-Haas Company Literature, “CLEARTRAN, Water-clear Form of Zinc Sulfide”, Web Site www.cvdmaterials.com/cleartra.html. (See other web sites under “CLEARTRAN”)
6. Gonzalez, R.C. and Richard E. Woods, “Digital Image Processing” Addison-Wesley Publishing Company, 1992. (See especially Chapter 9)

KEYWORDS: Imagers; Infrared Sensors; Visible Sensors; Security Systems; Dual-Mode; Seekers

N01-180 TITLE: Low-Cost Global Positioning System (GPS) Oscillator

TECHNOLOGY AREAS: Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT ID: PEO-W

OBJECTIVE: Develop a low-cost GPS oscillator that meets military GPS accuracy requirements.

DESCRIPTION: The development of the GPS navigation system has generated a myriad of users including weapons, aircraft, and ships. The GPS receivers, referred to as the user equipment, use a high-quality crystal oscillator to receive and properly interpret the GPS signals from the GPS satellites. This SBIR topic will address the development of a temperature compensated or other low-power oscillator that provides the same quality performance as today's oven controlled crystal oscillators without the size, weight, power, and cost penalties of the oven controlled oscillator.

PHASE I: Develop a crystal oscillator design concept and perform an analysis to verify that the design will meet the following characteristics. The oscillator will cost less than $125 (goal less than $50), use less than two watts of power, support fast response over the standard military temperature range (rated stability within 30 seconds - goal of 3 seconds), and provide good long term stability (2 ppm over 20 yrs) and good short term stability with a threshold of 1.0E -10 root Allan variance at t = 0.1 sec and root Allan variance of 6.0E-11 at t=1.0 sec (goal is 5.0E-11 root Allan variance at t=0.1 sec and root Allan variance of 3.0E-11 at t=1.0 sec). Initiate the design of an engineering prototype oscillator than can be fabricated and tested during Phase II.

PHASE II: Finalize the design. Fabricate and test the selected crystal oscillator concept evolving from the Phase I program. The testing of the engineering prototype should include testing over the entire environment range. Initiate producibility studies of the design along with production planning and design-to-cost analysis. Provide three test articles to the Government for early engineering assessment.

PHASE III: Build 10 production representative units that will be used by the Government for flight test, environmental qualification, and reliability development/growth testing. Provide engineering support via corrective action redesign resulting from the above testing.

COMMERCIAL POTENTIAL: This oscillator design is applicable for any commercial application of GPS that desires low-power utilization combined with rapid response. This oscillator would improve GPS performance where the receiver is subjected to electromagnetic interference such as business aircraft or helicopters flying in and out of populated areas.

KEYWORDS: Global Positioning System (GPS); GPS Receiver; Crystal Oscillator; Navigation System; Electromagnetic Interference; GPS-Aided Weapon Systems

N01-181 TITLE: Automated Strike Package Planning System

TECHNOLOGY AREAS: Information Systems, Sensors, Battlespace, Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: Joint Strike Fighter (JSF)

OBJECTIVE: Develop a prototype system for distributed low observable (LO) strike package planning, dynamic mission management, time critical targeting including aircraft and weapons deconfliction and airspace visualization, that meets the needs of the Joint Armed Services.

DESCRIPTION: Automated strike planning tools are needed to assist LO strike package mission commanders with performing strike package planning at the unit level. Unit-level integrated LO strike package planning is currently performed using mostly a manual process. Mission commanders in operational units expend significant effort in developing an initial strike package plan, coordinating the plan with the flight leads, reviewing the plan, assessing contingencies, preparing briefings, and revising the plan based on last minute changes. The process is essentially performed using STU-IIIs, paper maps, and note pads. The manual planning process is time consuming, inherently error prone, and does not guarantee consistent information dissemination across the units, especially if the units are at different locations. Furthermore, manual planning does not allow air vehicle and weapons deconfliction to be effectively assessed.

Current DOD Mission planning systems and systems under development fail to take advantage of emerging technology and will not be able to address LO requirements because of their architectural failings. It is common for mission planning programs to argue endlessly for one particular mapping package or another. While it is not an insignificant effort to design a planning system able to change from one mapping system to another, it is an essential ingredient to the successful joint planning system. Also, standard mission planning systems will not be able to perform LO tasks without significant redesign, time and money. Studies and prototypes built to convert non-LO systems to LO systems are painfully slow, inflexible and non-usable. In contrast, a system designed to do LO strike packages will be able to do non-LO strike packages seemingly without effort.

Mission commanders need automated methods to develop and disseminate strike package plans to LO strike fighter units [e.g. Joint Strike Fighter (JSF)] in a timely manner. Automated tools are needed to bring data from units to the commanders in near real time, display the data in a user specified format, deconflict the airspace to determine if the strike package is safe to fly, incorporate advanced LO tactics across the strike package, and electronically communicate any necessary changes to the units.

Effective automated tools would greatly improve integrated strike package planning and procedures, and would contribute substantially to the operational effectiveness and the survivability of LO strikes forces.

The goal of this topic is to demonstrate the use of emerging technologies in a basic distributed automated strike package and deconfliction planning system for LO vehicles that meets the needs of the Navy, Marines, and Air Force. This system should consist of integrating emerging technologies, and investigating and developing new and useful specific strike package algorithms. Passive Coherent Location (PCL) technology employed by an adversary will require new tactics and techniques to be performed by the strike force that could be best demonstrated, visualized and rehearsed on a LO planning system.

Current point-to-point deconfliction algorithms do not satisfy all of the requirements needed by LO strike package planners. LO vehicles rely on the preplanned missions to insure that they are not only out of harms way from enemy threats but also from contact with other air vehicles. The algorithm must take into account variances between the planned mission and the probable mission. These variances can be categorized as navigation error, altimeter error, early / late arrivals, variable aircraft speeds and winds, and tactical considerations. Another factor that must be included in the deconfliction of airspace is the need to, not only deconflict aircraft to aircraft, but also aircraft to weapon drops for any weapon in the airspace regardless of which aircraft deployed the weapon. As a part of the SBIR, a new deconfliction algorithm must be developed that would address these issues.

PHASE I: Conduct a proof of technological feasibility and assessment of operability and productivity of automated strike package planning systems. Prepare a systems definition document that details the strike package planning requirements for the JSF, and defines the automated system architecture and functionality needed to meet those requirements. The requirements for the system should meet the needs of the Joint Armed Services.

PHASE II: Develop a prototype, and finalize design and software system capabilities. Demonstrate capability in conjunction with scheduled field exercises (e.g., FBE, LOE, JEFX).

PHASE III: Finalize system design, conduct full-scale demonstration. Cooperative arrangement/licensing to aircraft manufacturers (e.g., JSF prime contractor), U.S. Government, and coalition partners.

COMMERCIAL POTENTIAL: The technologies developed under this SBIR project would have application in areas of air traffic management, collision avoidance, and air traffic operations, specifically safety of flight areas.

REFERENCES:

1. Classified materials not available to interested small businesses prior to selection. Further information will be posted on www.jast.mil or http://navair.navy.mil when appropriate.

KEYWORDS: Strike Package Planning; Airspace Deconfliction and Visualization; Agent Based Distributed Computing Architectures; Low-Bandwidth Communications; Platform Independent Software; Passive Coherent Location

N01-182 TITLE: Advanced Modeling to Characterize Failure Progression Rates from the Incipient Stage to Component Failure

TECHNOLOGY AREAS: Air Platform

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: Joint Strike Fighter (JSF)

OBJECTIVE: Develop and demonstrate advanced modeling techniques and programs that can be used to accurately characterize aircraft systems component (and/or sub-component) failure progression rates. The failure progression rates are to be characterized from the earliest incipient fault stages, incrementally through the final component (and/or sub-component) failure stages.

DESCRIPTION: In order to fully enable the predictive part of the Prognostics and Health Management (PHM) concept, there has to be some adequate level of understanding of the failure progression rate of the components (and/or sub-components) being monitored. This level of understanding can be acquired through careful and expensive “seeded faults” to failure tests conducted in a controlled environment; or through developing a knowledge base from actual (but rarely captured) fleet failures. A third way of acquiring this understanding of component failure progression rates would be analytically through the use of advanced models. This effort will develop, demonstrate, and apply these advanced models in support of the predictive part of PHM.

PHASE I: Define and report on a strategy to develop an advanced modeling program to characterize aircraft system failure progression rates from the incipient fault stage to final component failure. Develop a prototype-modeling program and demonstrate the feasibility of its use on an aircraft mechanical system component failure progression time history using, for example, spalled engine bearings or cracked gear teeth.

PHASE II: Develop an advanced modeling program or programs to characterize failure progression rates for several aircraft mechanical-systems components. Apply this advanced program or programs to accurately characterize the component and/or sub-component incipient fault failure progress rates for these aircraft mechanical systems, their components, and sub-components. These applications could include: bearing wear damage, blade crack growth, hot section erosion, and various gas path degradations for gas turbine engines; and bearing wear damage, gear teeth cracks and wear degradation for transmissions. Demonstrate how the fault failure progression rates provided by these models for these aircraft systems can be used to accurately predict a component failure event and to enable prognostics of the useful life remaining at any point in time. Assess the application boundaries and limitations for these modeling techniques.

PHASE III: Develop and deliver a complete set of application modeling programs to be use on several aircraft systems. Integrate the failure progression rate results of these modeling programs with a comprehensive Prognostic and Health Management (PHM) system. Apply these modeling programs a new aircraft development program like the JSF.

COMMERCIAL POTENTIAL: These advanced models would be applicable to any mechanical machine application that was applying diagnostics, prognostics, and/or health management capabilities. This is particularly true any rotating machines used in aviation, power plants, etc. The results gained from applying these failure progression rate models to particular systems would provide a significant cross over benefit to other similar applications, commercial or military.

KEYWORDS: Diagnostics; Prognostics; Modeling; Failure Progression Rates; Prognostics And Health Management; Failure Prediction

N01-183 TITLE: High-Temperature/Lower Cost Appliqué Material

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: Joint Strike Fighter (JSF)

OBJECTIVE: Develop an appliqué for aircraft that can operate in a temperature range of –65°F to 350°F. The material costs shall be lower than the currently developed fluoropolymer film/pressure sensitive adhesive. The applique shall meet the performance requirements of TT-P-2756, MIL-P-23377, MIL-P-85582, MIL-PRF-85285, and AMS 3603.

DESCRIPTION: The appliqué materials consist of a pressure sensitive adhesive layer, and a polymeric film. These appliqué material systems are being developed to replace the topcoat on aircraft. Currently applique systems operate in the temperature range of –65oF to 250oF. The next generation of flight aircraft will have an operational temperature range of –65°F to 350°F.

PHASE I: Provide an initial development effort that combines nontoxic corrosion inhibitors with a binder system to produce a lower cost appliqué system for use on Navy aircraft. The appliqué must meet the current military and performance specifications as well as be compatible with existing materials. Conduct preliminary laboratory testing to demonstrate the feasibility. Additionally, the application of the proposed applique should not interfere with the logistical and operational requirements of the naval facility tasked to use the appliqué.

PHASE II: Further develop the appliqué to meet the objectives of the Phase I result. Conduct both laboratory testing and field-testing

PHASE III: Produce the appliqué demonstrated in the Phase II effort. The appliqué will be transitioned to the Fleet through specification modifications and revisions to aircraft weapons systems technical manuals. If further development and/or field-testing are required, aircraft program funding or demonstrate funds will be pursued.

COMMERCIAL POTENTIAL: The appliqué can be used on commercial aircraft as well as non-aerospace applications for both the government and private sector as a replacement for paint. This material would be directly transferable to ships.

REFERENCES:
1. SAE ASM 3603, Protective Film: Polyurethane
2. MIL-P-23377, Military Specification Primer Coatings: Epoxy, High Solids
3. MIL-PRF-85582, Military Specification Primer Coatings: Epoxy, Waterborne
4. MIL-PRF-85285, Performance Specification Coatings: Polyurethane, High-Solids
5. TT-P-2756, Polyurethane Coating: Self-Priming Topcoat, Low Volatile Organic Compounds

KEYWORDS: Appliqué; Film; Paintless; Topcoat; Non-Paint; Polymeric Film